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WORLD PETROLEUM

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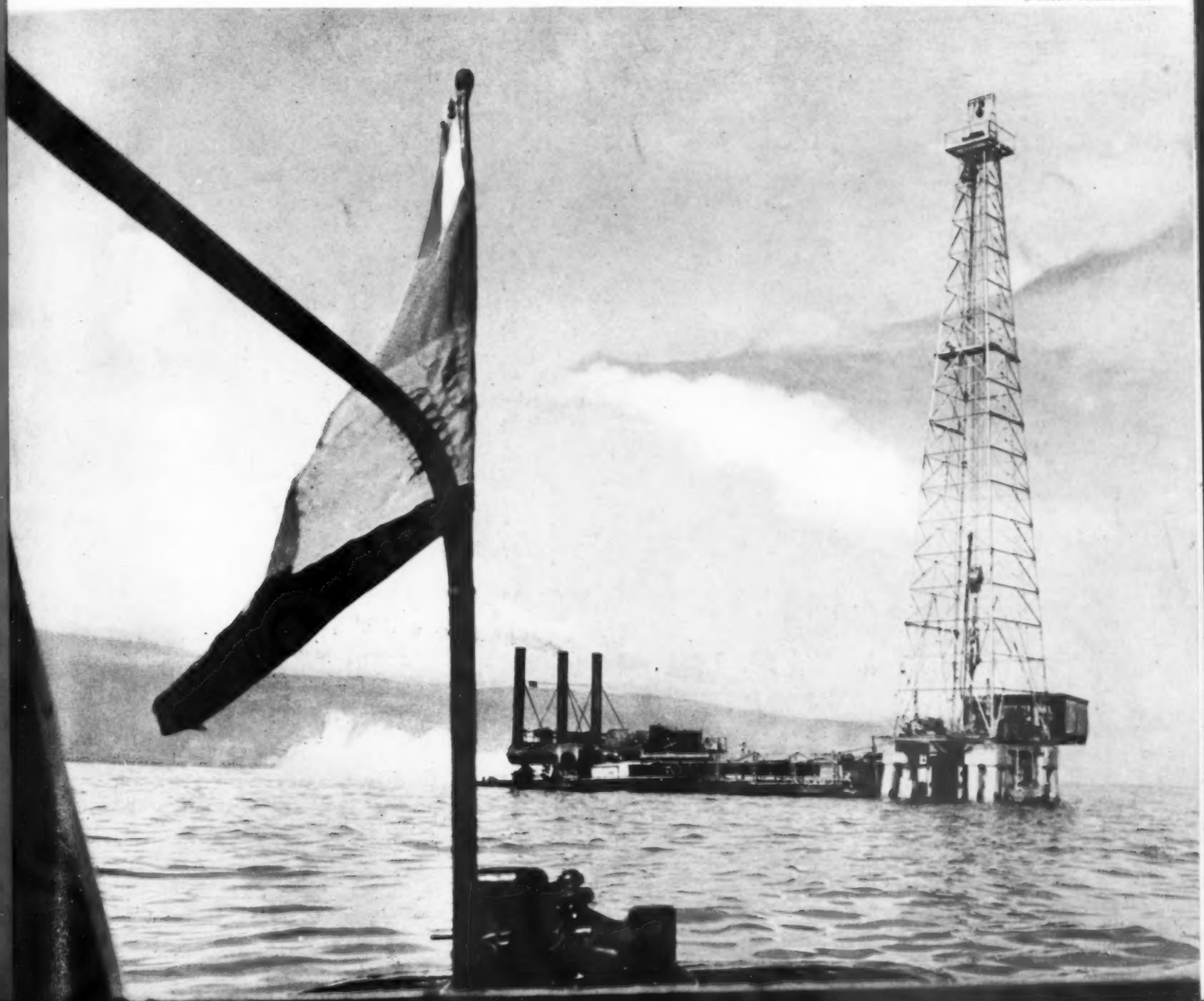

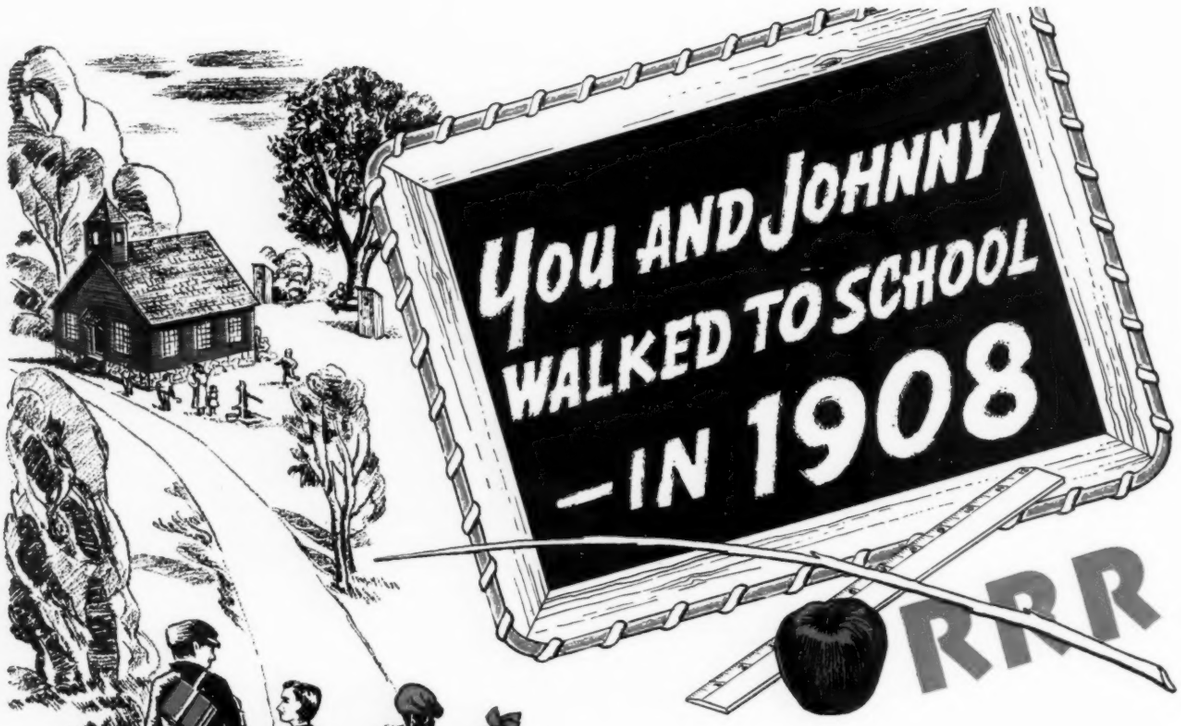

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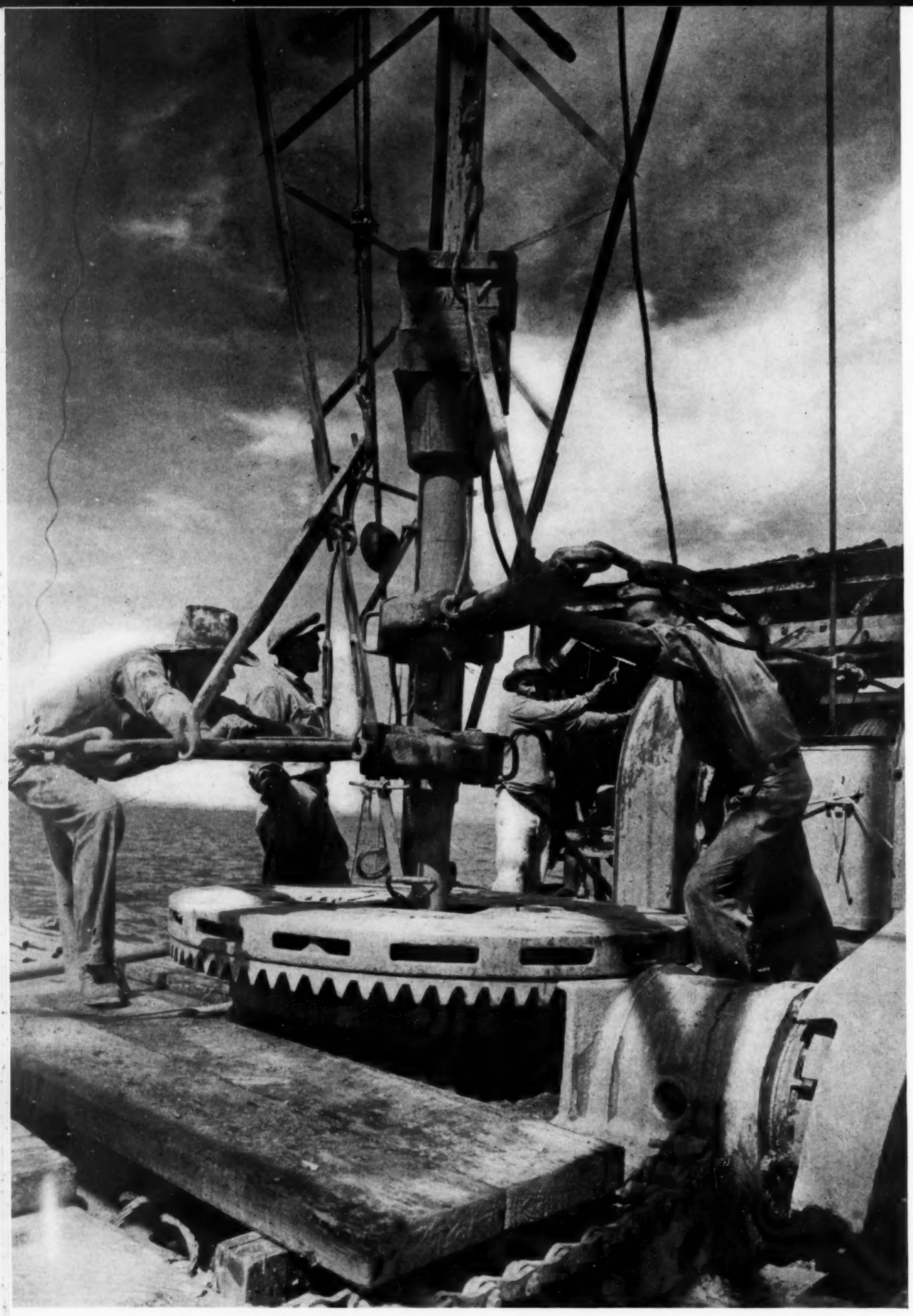

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Drilling in Lake Maracaibo :

Front cover picture shows this location as seen from an approaching launch.

EDITORIAL

OIL INDUSTRY IS PREPARED

AT ONE of the White House press conferences following the President's message to Congress on defense measures Mr. Roosevelt was asked to enumerate some of the particular steps that might be necessary in carrying out the program. In his reply the President was reported to have mentioned, among others, the possibility that additional refining facilities for the production of aviation gasoline might be needed. Since the discussion related to industries in which government cooperation with private enterprise might be required the thought in the President's mind apparently was that some government financing or other assistance might be called for in providing fuel for a vastly increased number of airplanes.

The statement, if correctly reported, was uttered in the course of running conversation. It was an offhand remark, made for the purpose of illustrating a general proposition and was not the result of study or investigation of this particular subject.

Fortunately for the country there need be no concern regarding an adequate supply of fuel for any land, sea or air force that may be created for its defense. The oil resources of the country are equal to any call that may be made upon them. Production can be stepped up at a moment's notice if the need arises. Surplus refining capacity exists and can be quickly expanded. New processes and new equipment for the production of aviation gasoline superior in quality to the best now in use have been developed in the past two years and manufacturing resources at the command of the industry are capable of providing on short notice whatever number of units may be necessary for its production in any quantity required.

Oil is one industry that is ready for the country's call. It is in a state of full preparedness. It can provide from its own resources without outside help increased raw material and additional plant for its processing. If a bigger fleet, a mechanized army and a powerful air force are needed for the nation's safety the American petroleum industry will not fail to supply the fuel and the lubricants essential to make them fully effective.

Mexican Issue Unchanged

WITHIN the past month two noteworthy developments have taken place in connection with the seizure of oil company property in Mexico. The first was the reply of the Mexican government to the note of Secretary of State Hull proposing that the dispute be referred to arbitration. The second was the action of the Mexican government in making a settlement with one of the companies whose properties had been seized.

Neither of these modifies in any respect the issue originally raised by the act of confiscation. In flatly rejecting the suggestion of the United States that the question whether the oil company shareholders were rightly or wrongly deprived of their properties be arbitrated the Mexican government asserts, in effect, that it is not bound by principles of international law nor by agreements which it has made with other nations unless it chooses to observe these.

While a presidential decree served as the authorization for ousting the oil companies from their business and properties the Mexican government attempted to give the act a greater semblance of legality by having it officially ratified by the Supreme Court of the country. As a preliminary, however, it was felt necessary to change the character of the court itself by making the term of its members a temporary one and by giving to the president the power of appointment and dismissal. By this course the court was robbed of its juridical character and was made a mere appurtenance of the executive authority.

More than this, it was necessary to reverse the many previous decisions by which the court, while it remained an independent body, had affirmed that the oil companies were entitled to the full enjoyment of property rights legally acquired. It was necessary, furthermore, to repudiate agreements between the

governments of Mexico and the United States embodied in the Payne-Warren and Morrow-Calles agreements and confirmed by diplomatic exchanges between the two governments on numerous occasions.

The fundamental issue in the controversy between the government of the United States and the oil companies on the one hand and the Mexican government on the other is the denial of justice in Mexico's refusal to recognize the subsoil rights guaranteed to the companies by Mexican law, that is the exclusive right to extract and dispose of oil beneath the surface in fields which they had legally acquired, explored and developed. So long as Mexico maintains this position its asserted willingness to compensate the owners for refineries, pipe lines and terminals taken over, subject to such offsetting claims as it can marshal in the form of labor awards and arbitrary fines, fail to meet the primary requirement of a satisfactory settlement.

The heaviest costs incurred by an oil company in undertaking operations in a new and unknown area are those involved in geological and geophysical surveys and in exploratory drilling to determine the existence of oil in commercial quantities. Too often a vast expenditure on this score results only in a series of dry holes and an empty treasury. To deny the company engaging in such development work the sole right to control and use the oil that is found is to exclude it from the opportunity of obtaining a return on its labor and investment. The title of land owners to oil beneath the surface of their properties is one that Mexican courts had reaffirmed in a long series of decisions over many years and that was explicitly recognized in exchanges between the two governments.

The patience with which Secretary Hull has conducted his side of the diplomatic correspondence and the fairness which he has displayed in offering to leave the whole matter in dispute to impartial arbitration apparently has been interpreted in Mexico as a sign of weakness. It may rather be regarded as an evidence of strong desire to reach a friendly settlement. No other method of conciliation than arbitrament presents itself. It has been employed by strong nations in hundreds of cases with no sacrifice of national pride or honor on either side. The unwillingness of Mexico to accept this proposal and its effort to lead the discussion into all sorts of bypaths suggests that its governmental officials may recognize the lack of support either in international law or Mexican law for their claims and their procedure in the oil property seizures.

Had Mexico accepted the proposal advanced by the United States the first task of the arbitrators selected obviously would have been to determine the legality of Mexico's action. If it had no legal justification the one possible method of repairing the wrong would have been by returning the properties to their rightful owners. Only in case it were decided that the taking of the properties was accomplished by fair and constitutional means would the question of reasonable compensation have come up for consideration. And even in the event of an award for losses inflicted the oil companies might still have been a long way from actually obtaining such compensation in view of the vast accumulation of Mexican obligations in default.

The position of the United States that expropriation without provision for prompt, effective and adequate payment is merely another name for confiscation remains unchanged. The position of Mexico as evidenced by this latest pronouncement is that her laws, her contracted obligations and her international promises are valueless if they run counter to the whim or the convenience of the individuals temporarily in power. It repudiates both the spirit and the principles on which any effective solidarity among the nations of the Western Hemisphere must rest.

Settlement of the claims of four subsidiaries of Consolidated Oil Company represents merely a private agreement. There can be no question of the legal right of the two parties concerned to arrive at a mutually acceptable bargain but it in no way affects the controversy between the two governments. Officials of the companies may very well have felt that a partial satisfaction of their claims was a better bargain for their stockholders than the uncertainty involved in a long and possibly fruitless handling of the matter through official channels.

For its part the Mexican government undoubtedly welcomed the opportunity to effect an arrangement with the owners of one of the less extensive of the seized properties, even though it involved a direct cash payment, because it placed them in a position to point to this adjustment as a proof of their willingness to settle the oil cases by direct negotiation. As a tactical move the promise to pay $8,500,000 to one of the smaller interests apparently was deemed to be worth its cost, but it has no real bearing upon the status of the case presented by the other companies.

WAR'S NEW PHASE Involves Heavy Petroleum Consumption

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France's heaviest tank, a 70 ton monster getting its baptism of fire on the German-French front: such equipment is responsible for greatly increased fuel consumption.

WITH the German drive through the low countries and France oil has assumed the role of importance in the European war which was generally assigned to it by expert observers at the commencement of the conflict. For eight months following the opening of hostilities the range of activity was so limited as to make slight demand upon the stocks of petroleum products which the belligerents had accumulated in advance of the struggle. In fact it is reported that the consumption of these products in the period from September to May was less than in peacetime. The requirements of the war machines were more than counterbalanced by the restrictions which were immediately placed upon the private use of petroleum products.

With the beginning of the big German push to the westward through Holland, Belgium and Luxembourg, this situation changed completely. The German advance was based to an extent never before attempted on motorized equipment. Planes, light and heavy tanks blazed the way. Motor cycle corps led the forward movement while motor-driven artillery and the huge number of trucks required to move munitions, materials, food and men constituted the main body of attack. Gasoline even has served as a direct weapon through its use by flame throwers. Although the fuel consumption of the invading forces undoubtedly has been much greater than that of their opponents the nature of the attack has forced the latter to employ planes, tanks and field artillery on a scale limited only by their material.

The amount of liquid fuel required by this latest phase of the war is a matter of conjecture since it depends upon the size, weight and speed of the vehicles employed. It is possible, however, to form an estimate of the fuel consumption of various types of planes and land vehicles. T. F. Wright, director of engineering of the Curtiss-Wright Corporation, said in a recent interview that on the basis of the reported employment in the Flanders campaign of 4,000 German planes of which 60 percent were bombers, and assuming that these planes were in service up to but not exceeding five hours per day, the fuel requirements of the bombing contingent would range from 90 to 150 gallons per hour for each machine or from 26,000 to 43,000 bbl. daily for these planes alone.

Fuel requirements of pursuit planes are estimated at 100 to 116 gallons per hour depending on the time spent in full throttle operation. For 1,600 planes of this class fuel requirements would amount to roundly 22,000 bbl. per day. While the number of planes on the Allied side has been smaller they have engaged in longer flights and it is reasonable to assume that their fueling required at least 75 percent as much aviation gasoline as has been used by the Germans. On this basis it may be computed that the war in the air during the recent period of intense activity has been using 100,000 to 125,000 bbl. of aviation fuel daily.

The armed tanks which have played such a conspicuous part in the fighting on both sides are of two classes. Light tanks which lead the advance consume about thirty gallons of fuel per hour. These fast machines, capable of making thirty to forty miles an hour, require high test gasoline. The number being used in the campaign is not known exactly, but it is probably safe to say that another 60,000 to 70,000 bbl. of fuel are being used in this branch of the service. The heavy tanks, on the German side at least, are fueled by Diesel oil.

For the service of supply and transport of men both gasoline and Diesel oil are employed and no statistics are available as to the proportion of each class of truck in use. Taking into account the number of troops engaged and the number of motor vehicles required to service these armies it is a safe assumption that 100,000 bbl. of fuel are used daily.

The consumption of petroleum products in actual fighting is of course superimposed on the other requirements of the war. The intensification of combat actually increases these requirements since it involves the movement of reserves and supplies far behind the lines. The task of feeding to the armies in the field the amount of fuel needed to maintain their efficiency in itself engages great fleets of trucks, while other great numbers are required for the movement of munitions, supplies and food. From towns and manufacturing plants far behind the lines the Germans must keep a constant stream of fresh supplies moving toward the front over distances that extend to hundreds of miles. In the case of the French and British much of this supply material is brought across oceans in oil burning ships and then must be moved by land transports to the places where it is needed. In the first world war it was calculated that this service of transport and supply called for ten times as much gasoline and fuel oil as was used in actual battle movements, but in the present war the ratio is unquestionably less because of their greater use within the zone of combat. Even if the relative demand is figured at only two to one the consumption of these products by the contending forces is probably at the rate of over 30,000,000 tons or over 200,000,000 bbl. yearly, leaving out of account the consumption by naval and supply vessels and in the industrial operations related to the war.

Competent observers estimate that the

(Continued on page 48)

SWEDEN'S Projected Gasoline Pipeline

By Harold W. Wickstrom

IN 1938 the Svenska Entreprenad Aktiebolget, one of the largest and best known Swedish engineering and construction companies retained the Southwestern Engineering Company of Los Angeles, California to investigate the possibilities of improving the methods of transporting gasoline in Sweden with particular reference to the use of a pipeline system.

The writer was given the task of preparing the estimates of cost of construction and operation and the mechanical design of the proposed line and submitted a preliminary report in 1938 for the consideration of the engineers of Svenska Entreprenad Aktiebolget.

The conclusions reached in the first investigation were that the construction of the line was feasible from both an engineering and economic view point.

To investigate and study the problem more thoroughly, the writer was called upon to visit Sweden in January of this year and will attempt in this article to explain the scope of the project, some of its engineering features and its economic possibilities.

Normally most of the gasoline used in Sweden is shipped from the Gulf Coast of the United States of America to Göteborg and Stockholm and from these points it is distributed by small tankers or rail to the points of consumption.

During the winter months all of the canals and lakes are frozen over and at times the Baltic is impassible to tankers on account of ice. It is then necessary to ship all of the gasoline from Göteborg by rail.

Due to war conditions the cost of insurance on tankers traversing the sea route around the southern coast of Sweden and into the Baltic is prohibitive, making it desirable to unload on the west coast.

Harold W. Wickstrom

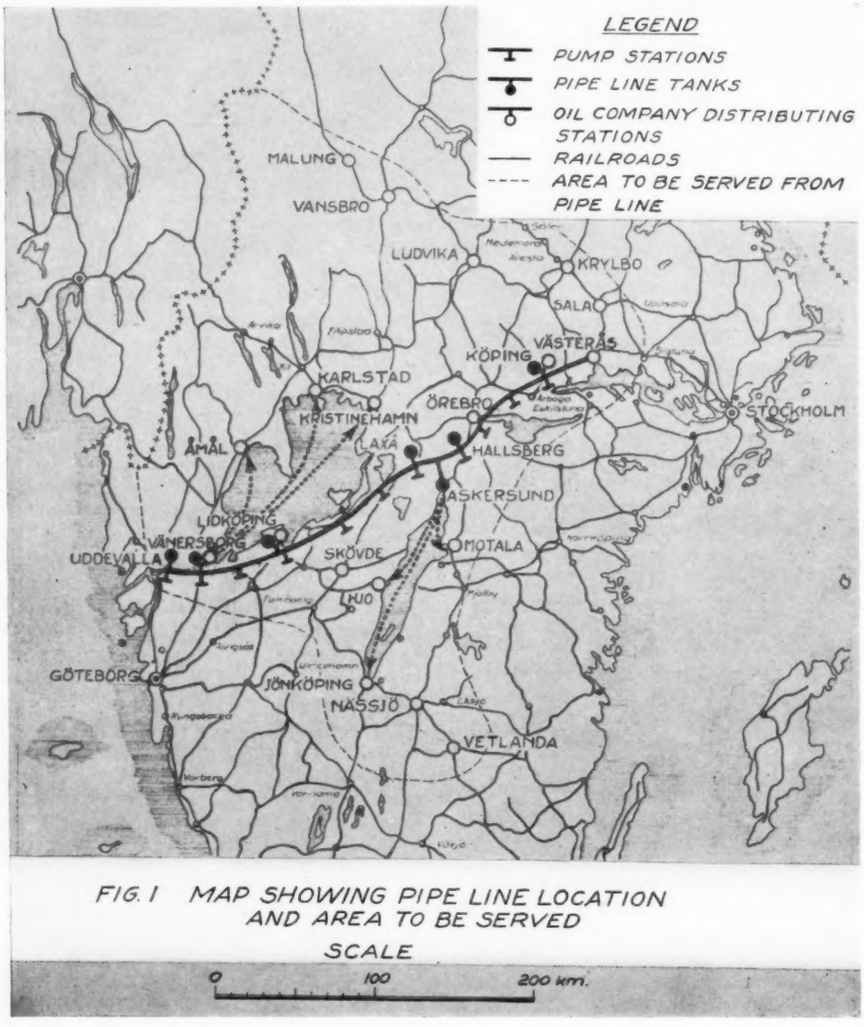


FIG. 1 MAP SHOWING PIPE LINE LOCATION AND AREA TO BE SERVED

The proposed line across Sweden has a point of origin at Uddevalla and extends east and north through Vänersborg, Lidköping, Mariestad, Laxa, Hallsberg, Örebro, Köping to Västeras with a branch line from a point near Laxå to Askersund. The total length is approximately 350 kilometers. (220 miles).

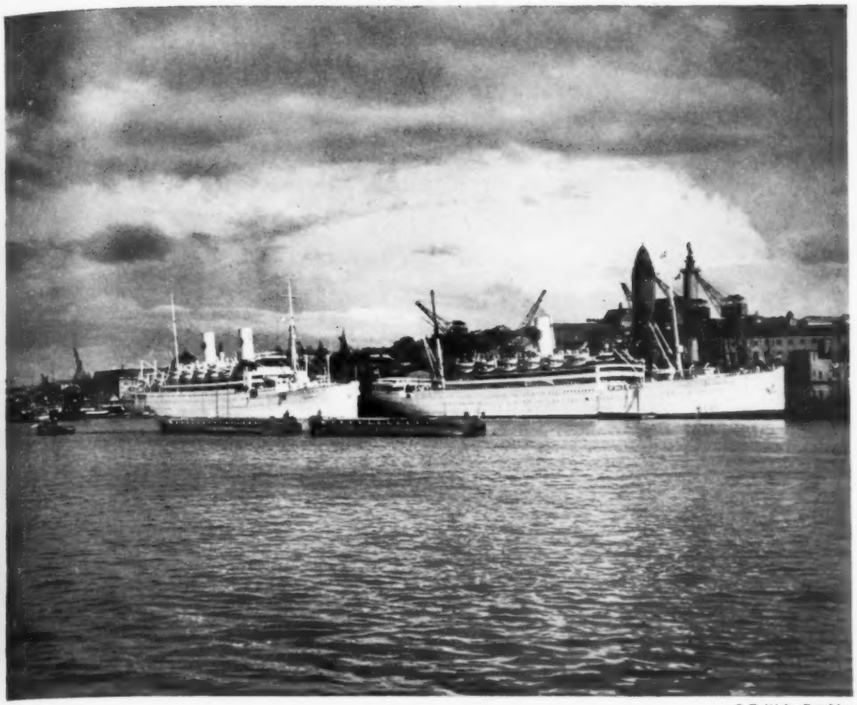
Bulk storage is proposed at Uddevalla, Vänersborg, Askersund, Laxa, Hallsberg and Köping. From these points the area enclosed by the dotted line on the map can be economically served from the pipeline. The heavy lines on the map indicate railroads. The lakes shown are all interconnected by a canal system.

In the summer time gasoline would be shipped by lake tankers from storage on the line to distribution points favorably located and the balance of the area would be taken care of by rail and truck shipments.

As the winter use of gasoline is materially less than summer consumption the same rail cars and trucks can handle the winter load even though the tank ships are tied up.

There are several distributing companies operating in Sweden and the success of the project requires the cooperation of at least some of them as the total consumption of gasoline in the country is not great enough to justify a pipeline unless most of the volume used in the area to be served is transported through the line.

It is estimated that the consumption of gasoline within the area that can be economically served by a pipeline was 250,000 cubic meters (65,000,000 gallons) in 1939. The normal rate of increase of use is approximately 5 percent per year. The possibility of a continual increase in volume consumption



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Göteborg, principal port in the west of Sweden through which much of Sweden's oil supply now comes; distribution inland depends on rail and truck, is sufficiently costly to justify a cross country pipeline.

in Sweden is very great as the per capita consumption is low at the present time. With the continuation of their good roads program and the increasing number of tourists visiting the northern countries, coupled with the high standards of living, a steadily expanding market appears reasonably certain.

The distribution from the line is estimated to be divided approximately as follows:

Vänersborg	25%
Lidköping	15%
Laxå	10%
Askersund	10%
Hallsberg	10%
Köping	15%
Västerås	15%

The design of the line provides for a maximum capacity of 400,000 cubic meters per year from Uddevalla to Vänesborg and 300,000 cubic meters per year from Vänesborg east.

To handle these quantities requires 5 in. pipe from Uddevalla to Vänesborg and 4 in. the balance of the way, with a 3 in. branch line to Askersund.

The terrain to be crossed varies from level country to rolling hills with a maximum elevation of 560 ft. between Mariestad and Hallsberg. There are many canals and river crossings and provision for these was allowed, some being overhead and others under water, depending upon the local conditions encountered. Due to the long cold winters it is necessary to bury the line with at least three feet of cover. This is simple for 75 percent of the length but 25 percent of the right-of-way passes through rocky areas. These conditions are characteristic of Sweden where in many places granite outcrops cannot be avoided.

Welded construction is planned, using 40 ft. lengths of pipe. No soil survey was made so a pipe protection program was not worked out. Sufficient amounts were allowed in the estimate to treat the entire line with asphalt or bitumastic plus two wraps of celulose acetate and a final asphalt coat and kraft paper wrap.

To provide the line with the capacities stated, requires eleven pump stations. The location of these stations was determined after taking into consideration friction losses, elevations to be crossed and flexibility of operation of the line in either direction.

The reverse direction is necessary to allow for pumping from storage in the center of the country to either coast and to take care of gasoline refined on the east coast.

All stations are of identical design excepting the initial station at Uddevalla which will have two pumps.

It is planned to use 20 stage Byron Jackson Hydro Press Type Pumps with submersible motors. These pumps will give an efficiency of 70 percent even at the high heads and small capacities involved.

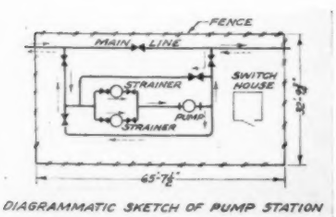

FIG 3 DIAGRAMMATIC SKETCH OF PUMP STATION

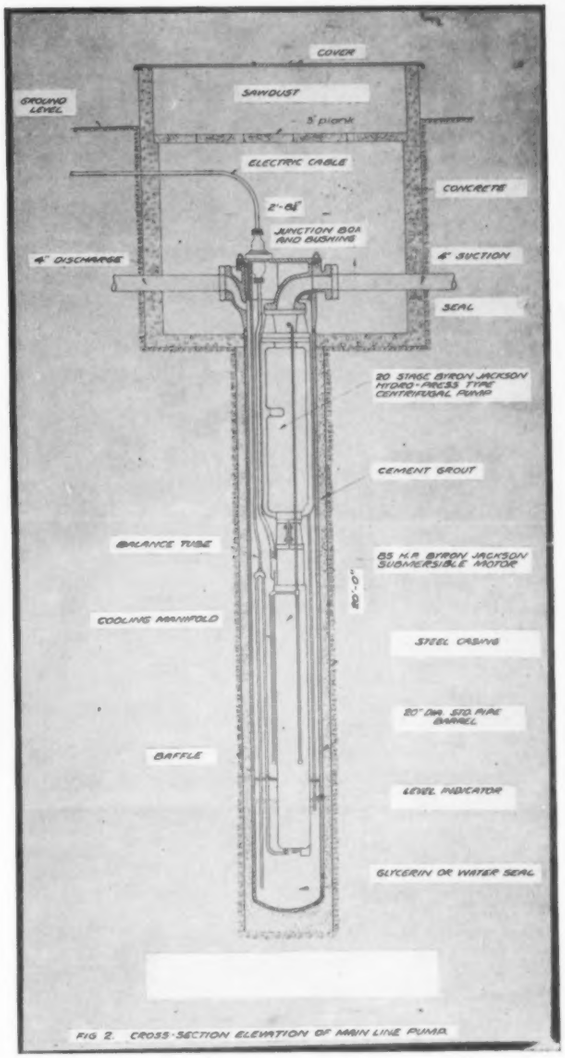

FIG 2. CROSS-SECTION ELEVATION OF MAIN LINE PUMP

The discharge pressure of the pumps is 520 lbs. per square inch above the suction pressure. The suctions of the pumps take off directly from the pipeline without the gasoline going to a balancing tank.

Both the pump and the motor are enclosed in a steel cylinder which is about 20 ft. long and 20 inches in diameter. This cylinder is lowered into a vertical hole in the ground and grouted into place. The pumps and motor assembly can be removed for inspection or repair by taking off the top flange of the cylinder and pulling the motor and pump unit out vertically.

The motor is built in a cast iron case and runs in a bath of high dielectric value low viscosity mineral oil. Contamination of the oil by the product being pumped is prevented by a mercury seal on the shaft between the motor and the pump and by use of a high specific gravity liquid seal in the bottom of the cylinder. Provision is made for expansion of the oil in the motor chamber by balancing tubes. The motor is continuously cooled by the gasoline being pumped which is in contact with the outside of the motor casing. The motors are 85 h.p., 440 volt, 3-phase, 2-pole and run at 2,950 r.p.m.

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The other port of entry for Swedish oil supplies is Stockholm, harbor, airport and gasoline storage tanks of which are shown in this picture.

This type of construction eliminates packing glands and lubrication. With the elimination of packing glands and lubrication there is no need of station attendants except for starting, stopping and valve manipulation.

To make a pipline with small capacity economically feasible it is necessary to reduce the pumping costs.

This is accomplished by full automatic control from a central dispatcher's office. All operating valves on the line or at the stations are motor operated.

By means of telephone circuits relays can be operated which in turn open or close the power circuits to open or close valves or to stop or start the pumps.

A control board in the dispatcher's office indicates with lights the position of all valves if open or closed and the condition of each pump if running or stopped.

To protect the line further the pumps are provided with over pressure shut off controls and in case of a line break pressure regulator controls stop the pumps.

Deliveries can be made out of the line into storage tanks located at convenient centers of distribution and when delivery is made quantity and quality are accounted for and the consignee takes receipt of the product and is billed for transportation charge.

Products of various companies and various specifications can be handled simultaneously. This is accomplished by maintaining a vigilant control over the dispatch and delivery of shipments. A pipeline full of gasoline can be visualized as a moving uncompressible column of liquid with the foremost increment being continuously withdrawn and being replaced with an increment of like size at the originating point. That the specifications of the forward increment need have no relationship to the hindmost increment is evident.

The location of any shipment, which is a section of the column of liquid, is known at all times by the dispatcher as he keeps a continuous record of products pumped into the line and removed from the line by converting the volumetric measurement into linear measurement. For example a shipment of 1,000 bbl. would be equivalent to a column of liquids approximately 12 miles long in a four inch line.

When the front end of a shipment is due to arrive at the point of delivery a gauger is sent to that location. He takes samples from the line, and to aid in determining when to turn the gasoline into the tanks he is guided by the change in color of the gasoline as a slight amount of coloring matter has been introduced into the first few barrels of the shipment at the point of origin. When delivery is started into the receiving tanks, the time is noted and the dispatcher is advised by telephone. He in turn advises the gauger the number of barrels to put in the tank before making another change in the valve position. Simultaneous withdrawals can be made from several places in the line as long as the total rate of all withdrawals is not greater than the flow capacity of the line.

The estimated construction cost for the entire project including provisions for organization and starting the line in operation is 7,000,000 SW Kronor ($1,200,000).

The time required to make the installation would be five to six months working during the summer season.

Operating costs consist of fixed costs that will not vary with the amount of gasoline pumped and power costs that will change with the amounts handled and the distances pumped.

Fixed cost includes depreciation at 5 percent per year and interest on investment of 5 percent per year plus wages, overhead charges, maintenance and repairs. They will total approximately, 1,000,000 SW Kronor per year ($240,000).

With electric power estimated at 4 Ore per kilowatt hour (1c) the following table of approximate rates was developed which will return sufficient income to cover all operating and fixed costs.

Approximate Rates

	200,000 m³ per year		300,000 m³ per year	
	Bbls./day		Bbls./day	
Uddevalla to—	Kronor per Ton	Cents per Barrel	Kronor per Ton	Cents per Barrel
Vanersborg	3.25	12.7	2.15	8.15
Lidkoping	6.25	23.6	4.20	15.9
Laxa	6.45	24.4	4.26	16.1
Hallsberg	6.55	24.8	4.33	16.4
Askersund	6.55	24.8	4.33	16.4
Koping	6.74	25.5	5.10	19.3
Vasteras	6.93	26.2	5.17	19.6

These rates are considerably lower than rail rates or combination rail and tanker and offer an inducement to large shippers.

The reduction of handling due to transfer of gasoline to cars and barges and loss in transit will amount to 1.00 to 1.25 percent.

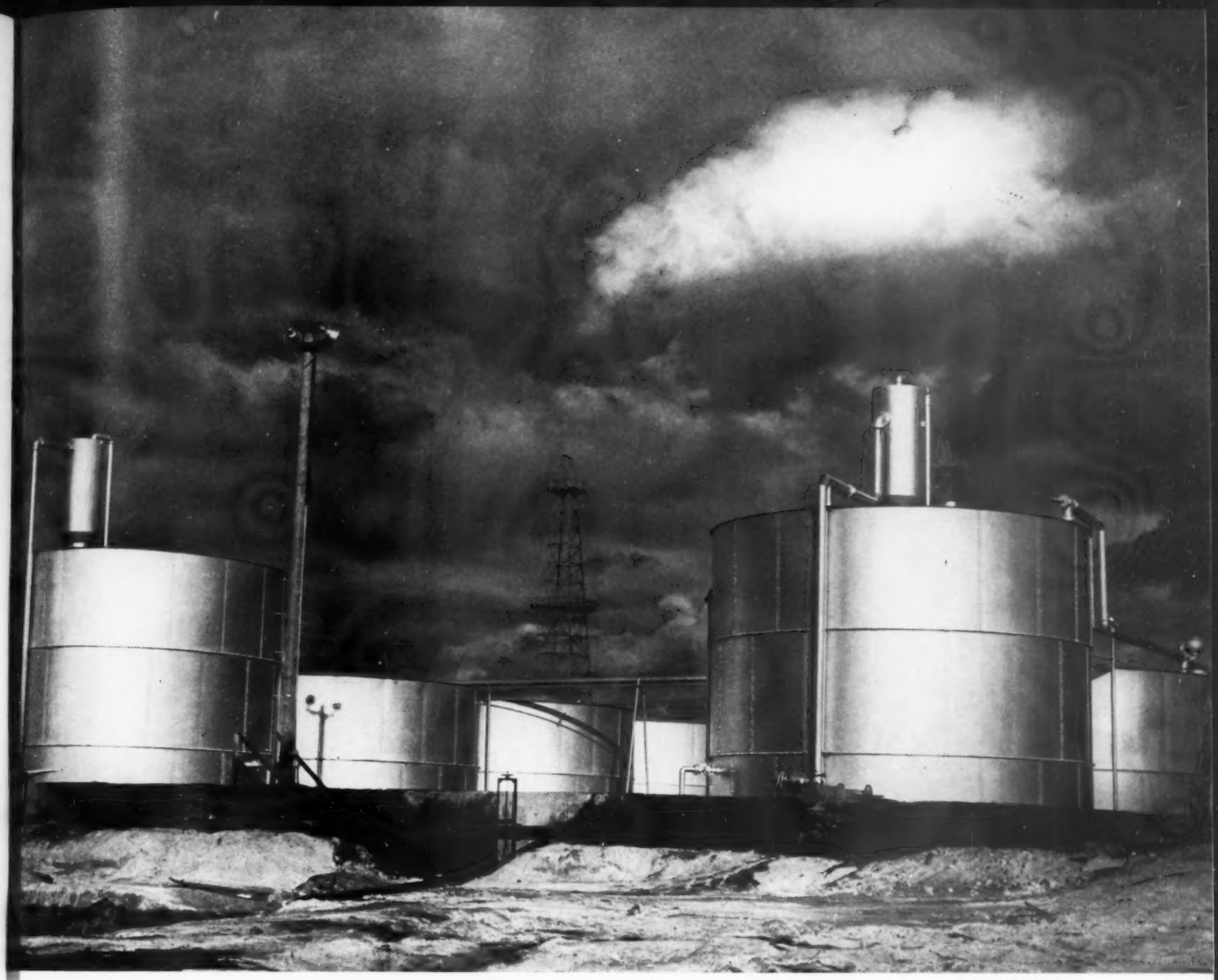
The line is proposed to operate as a common carrier either as an adjunct to the Swedish National Railways or as a separate company financed partly by private capital and partly with government funds.

The advantages of a gasoline pipeline with adequate reserve storage of gasoline in time of war is evident and this consideration was an important one in the selection of the location of the line and the terminals.

Due to the rapid change of events in northern Europe now in evidence which were anticipated in January and February all work on the project was stopped suddenly and the writer returned to the United States in March. No work will proceed until after the present conflict is over, but it is confidently expected that the work will be resumed and the entire program will proceed to a successful conclusion at that time.

The significant feature of this study is that transportation of gasoline by pipeline, even though the quantities to be handled are comparatively small, is entirely feasible and by the incorporation of packingless pumps and automatic control the economic picture becomes very favorable.

There are many locations in the United States and other countries where transportation costs could be materially reduced and a fair return realized on the initial capital investment by a cooperative operation of small gasoline distribution lines from receiving terminals or refineries to outlying substations and consuming centers.



© Cy La Tour & Son

Additional storage capacity may be required if distillate fuel output is to be maintained throughout the year.

Meeting the Problem of UNBALANCED STOCKS

Leading Members of the Industry Comment on World Petroleum's Discussion of This Subject and Agree That Excessive Winter Accumulations of Gasoline Can Be Avoided.

WHILE the building up of gasoline stocks during the winter season has long been the practice of the refining industry in the United States the mounting size of these stocks has been the cause of criticism and concern for the past several years.

Since the consumption of motor fuel follows a well defined cycle with its low point in midwinter and the peak of demand in the late summer it is logical and even necessary that refiners should accumulate supplies of gasoline in the cold season, moving these to storage at bulk terminals where they are readily available for distribution during the active period of the motoring season. But when these stocks pass beyond the dimensions of a needed reserve, and particularly when they approach the limit of available storage, they are regarded as a threat to market stability. As they reach their maximum in the month of April, just when the season of enlarged demand is getting under way, they create insecurity at the very time when price demoralization would have the most serious effect on the industry.

While the danger in this recurring situation has been pointed out in many quarters very little was offered in the way of practical suggestions for removing it. Impressed by this fact WORLD PETROLEUM, during the past several months, has published articles directed to a correction of the situation and considering both the economic aspects of the problem and the technical manufacturing factors affecting it.

These articles have been followed by other studies and discussions and have brought to WORLD PETROLEUM a great number of

letters from which it appears that many refiners are giving thoughtful attention to the question of shaping their own operations along such lines as to avoid contributing to the unbalance in stocks which reached such formidable proportions during the past season. A number of these letters presented new angles of the subject or elaborated points not fully developed in the original articles.

As was brought out in the earlier articles referred to, the maximum level of gasoline supplies has risen rapidly from year to year as is shown by the following tabulation giving the figures of finished and unfinished stocks and the dates of their high point during the past four years.

	Date	Bbl.
1937	Mar. 27	83,538,000
1938	Mar. 19	93,192,000
1939	Apr. 22	87,769,000
1940	Apr. 20	102,817,000

Explanation of this constantly rising accumulation, as was pointed out in this same article, is to be found in the fact that during the past four years the demand for light fuel oil has increased at practically twice the rate of the growth in gasoline consumption, coupled with the continued practice on the part of manufacturers of waiting until the fourth quarter of the year to step up the production of distillate fuel.

It was developed in one of these articles* that if the fuel oil yield were maintained during the summer months at the same proportionate level as during the winter, distillate stocks would reach a point sufficiently high at the beginning of the season of heavy consumption for this product so that the necessity of producing excessive stocks of gasoline would be avoided. The plan of maintaining a more uniform yield of distillate fuel throughout the year is one that has been recommended and that is being adopted by certain large refining companies.

Such a proposal raises a question of storage which is discussed in a letter from the president of one of the large refining companies. His letter in part is as follows:

> The article in March WORLD PETROLEUM is very sound and interesting. One point, however, which seems to me not to have been dealt with fully enough is the storage problem.
>
> As long as the demand for distillate fuel was running under 12 percent of the crude runs, it was a fairly simple matter to make around 10 percent during the summer months and enough more during the winter months to take care of whatever kind of weather we had, and thus not have to build up excess stocks. However, as the average demand approaches the distillate fuel capacity of our refineries it became practically impossible to take care of a hard winter by making more distillate fuel, and to achieve this balance it appears necessary to make rather high percentages of such fuel the year round. This in turn means that we must provide substantially more storage, preferably in northern ports, than we have had in the past.
>
> It is now apparent that we must start out each fall with far higher stocks than we have had in the past. As a result, we have constructed tanks at several of our northern terminals and also have arranged to convert certain gasoline tanks into distillate fuel service near the end of the summer, and if that process is generally followed, I think the problem will be solved. It will also prevent the depressing effect of distress prices at the end of the summer.

At the end of the winter season available storage has been filled with gasoline representing production above demand during the months preceding. It has been a matter of convenience for refiners to ease their distillate output as demand for the product tapers off and to wait until the final quarter of the year before starting to accumulate stocks in quantity. By that time many of the tanks that were filled with gasoline early in the year have been emptied and are temporarily available for fuel oil.

Storage facilities adequate for distillate fuel as well as gasoline can be provided and reports from a large number of companies indicate that storage capacity is being increased for the primary purpose of carrying larger stocks of light fuel oil. Such construction requires additional investment and some refiners have been reluctant to increase their investment merely to carry a product sold on the narrow margin that has prevailed for heating oil, the more so as the price has shown a tendency to weaken during the later months of the year. It is admitted, however, that it would be preferable to make the expenditure involved in providing tankage for additional supplies of distillate rather than to imperil the market position of gasoline through the accumulation of dangerously large supplies.

This idea is expressed by the chief executive of another large company who writes:

> I agree with the article (March WORLD PETROLEUM) that the principal difficulty in providing sufficient light fuel to meet the market demand has been brought about by the lack of foresight on the part of refiners to store up sufficient domestic fuel during the summer months.

Not only in the matter of providing storage but in other ways as well the handling of light fuel oil in the past has been treated by the majority of American petroleum companies as a minor and wholly subsidiary branch of their business. Gasoline production remains the predominant objective of refining operations. But while fuel oil still occupies a subordinate position that position is of such importance in the general scheme of company operations that it is being widely recognized that this branch of the oil business should be put on a sound economic basis.

There has been a general feeling that the grade of fuel oil used in domestic heating has been selling at too low a price in relation to other products. Under the operation of demand and supply the price has advanced recently to what appears a more reasonable level but adjustments of this nature take place slowly because of the prevailing custom of selling to consumers on yearly contracts by which prices are guaranteed not to exceed a stated maximum.

Little exact information is available as to the cost of individual products of refining. For inventory purposes most companies adopt the convenient accounting device of charging costs in ratio to selling price. As a result the tendency among the manufacturing and marketing divisions of the industry is to accept these values as real when actually some of them may be decidedly out of line.

This phase of the subject is discussed in a letter from an official of a large independent refining company which purchases a substantial part of its crude. From his letter the following extracts are taken:

> The unbalanced relationship between stocks of gasoline and light fuel oil is unfortunate. Perhaps it is not for the refiner to complain, however; he should immediately respond to the demand of the market by putting his own house in order.
>
> Strength in the fuel oil market is offset by weakness in the gasoline market. In our opinion, inventory values should not be stubbornly protected. We keep our inventories at minimum, which permits us to change our operations almost immediately in order to meet changing demands of the market.
>
> When we buy a barrel of crude oil for processing, we add the cost of the crude oil into the plant to the cost of processing and apportion the resulting cost to the products obtained in proportion to the sales values of the several products. Costing on this basis decreases the inventory value of our gasoline and increases our cost for light fuel oil, as the price of gasoline goes down and the market price for light fuel oil goes up.
>
> The foolishness of accumulating gasoline inventories above requirements in order to produce light fuel oils to sell on what might appear to be an attractive market is readily apparent when the consequences are realized. If increased gasoline inventories result in depressed prices for this product, the cost thereof should be reduced, with resulting increase in cost for producing light fuel oils. When this adjustment is taken into account it can be shown that light fuel oils are being sold too cheaply. If the price of light fuel oils then advances to a proper level, there would be either a slackening of demand or resulting profitable operations, regardless of the selling price of gasoline.
>
> The trouble with the oil business today is that the price of crude oil bears no fair relationship to the selling price of the several products obtained from processing it. Every effort is made to maintain what is now a too high price for crude oil at the well. If the industry is to cure its ills, it would be my suggestion that all crude oil be purchased at prices strictly dependent upon market value or selling price of the product produced, thereby insuring the refiner a reasonable return on his investment represented by an overall profit on each barrel of oil processed.

In preliminary discussions of the subject one of the obstacles to the establishment of a better balance between gasoline and fuel oil supplies which was frequently cited was the necessity confronting certain refiners of cracking the whole of their distillates in order to maintain a high octane rating for their motor fuel. It is noteworthy, however, that among the many correspondents who have written letters of comment based on the articles previously published none has raised this objection. It appears to be taken for granted that refinery operations have attained a degree of flexibility that makes it possible to turn out products in such ratios as may be dictated by trade demand.

In an article written for April WORLD PETROLEUM by an official of one of the largest

*World Petroleum, April 1940, pp. 28-32.

Solution to the problem of excessive motor fuel stocks resulting from high runs required to meet distillate fuel demand in winter may be found in modifications of existing refinery and storage set-ups.

of international companies it was pointed out that this particular company had found it possible to raise its ratio of fuel oil to gasoline to a basis that enabled it to supply the demand for both products without any burdensome accumulation of either. Refinery managers almost without exception agree that in a modern refining plant the problem of regulating output to coincide with the demand for the various products obtainable is one that presents no serious difficulty.

Thus, the marketing head of a prominent midwestern company writes:

> It occurs to us in reading the articles that the authors have definitely gotten into the heart of the over-all picture in the recommendation that refinery runs should be based on gasoline demand at all times and that stocks of light fuel oil might well be conserved in the summer and fall months in anticipation of the winter demand, to a point that would enable refinery runs during the winter months to be considerably lower than has been the case during the past two years.

The president of one of the largest and most active companies in the country makes the following comment.

> It is my opinion that gasoline stocks are entirely too high at the present time, due principally to a lack of balance between production of gasoline and of furnace oil and other light fuels. From a long-range viewpoint, it is difficult to form a definite conclusion, owing to the uncertainty of a number of the factors such as possible effects of the war, the tanker situation, and others, but I believe the industry may expect a very unsatisfactory price situation next winter unless refiners in general can find and adopt a better method of estimating demand and of regulating running to meet the demand for light fuels and at the same time maintain the proper balance between the production of gasoline and of middle distillates.

The number of companies, large and small, that have gone on record as taking steps to modify their own operations in such ways as will provide larger supplies of light fuel oil at the beginning of the season of high consumption and thereby avoid the necessity for excessive gasoline production in the winter months indicates not only that the problem is by no means insuperable but that it is in fact on the way to solution. The whole subject is very well summarized by the head of the refining department of one of the most progressive companies in the country who writes as follows:

> I feel that the publication of these articles is most timely since we ourselves have for sometime been worried by the increasing demand for both distillate oils and heavy petroleum residuums.
>
> There are, as you say, two avenues of approach to the solution of this problem. One is an increase in the price of these fuels to a point where the advance in consumption will be retarded through the continued use of coal, or possibly through the conversion of some oil burning equipment to solid fuels. The other is the rearranging of plant equipment to make possible higher percentages of fuel oil as compared with gasoline. To my mind the problem will be solved by a combination of both of these methods. My conclusions are:
>
> First, heavy fuels should be priced in reference to coal on the basis that will keep output in line with normal production of heavy fuel as a by product of gasoline and distillate fuel requirements.
>
> Second, plant equipment should be so arranged as to make possible conversion of varying quantities of distillate fuel into gasoline, thus making it possible to keep these two products in balance.
>
> Third, these two products, namely, distillate fuels and gasoline, should be priced so that the difference between them represents conversion cost of distillate fuel oil into gasoline by modern cracking processes.
>
> Fourth, the sum of heavy fuel, plus distillate fuel, plus gasoline prices in their proportion of production, plus refining costs must, of course, show a profit to the refiner on his crude.

As a result of the discussion that has taken place it appears that the factors involved in preserving a proper balance between gasoline and distillate fuel are coming to be better understood, that the accumulation of excessive stocks of gasoline during the season of low consumption can be avoided by maintaining a more uniform rate of fuel production throughout the year and that many refiners are moving to adjust their operations to such a program. It has been shown on good authority that the plant alterations needed for such a change are not great, involving, for most refineries, merely the installation of some further fractionating equipment on cracking units and the more extensive use of treating and rerunning, plus the additional storage needed to take care of the higher yields of distillate during the summer. The steps necessary to elimination of one of the disturbing and potentially dangerous situations in the industry are relatively simple and can be worked out by the managements of the various refining companies to suit their special conditions.

525 MILLION BARRELS In Sight in Illinois

By Gail F. Moulton

Petroleum Geologist, Vicepresident
Ralph E. Davis, Inc., Engineers.

Continuation of Present Volume of Production Depends on Maintenance of Past Extraordinarily High Rate of Discovery Which, Though Possible, Appears Unlikely. Per Well Production Declining. Pressure Maintenance and Other Forms of Conservation Spreading.

A CLIMAX in the rejuvenation of the oil producing industry in Illinois was reached in March 1940 when third place among the oil producing states was regained for the first time in 25 years. During 1915 the discovery of important new fields in Texas and the continued decline of the Illinois fields had resulted in the loss to Texas of the place held for seven years among the three leading oil producing states of that earlier period. Beginning in March 1940 the average daily production of the state has been more than 425,000 bbl. per day, exceeding any other state except Texas and California. The spectacular development of this high rate of production in less than three years has attracted the attention of oil operators in all parts of the country. There can be no doubt that the rate of oil production and the reserves of the newly discovered fields are great enough to merit the careful consideration of the industry as a whole. The magnitude of oil reserves being developed, the probable future rate of production and the length of the period during which oil production in this region will continue to be an important factor in furnishing the requirements of the central refining district are all vital questions. The purpose of this discussion is to present data bearing on these questions and to indicate general answers which appear reasonable at the present time.

The Illinois Basin is a geologic province centered in Edwards and Wayne counties, Illinois. For considerable distances in all directions the general dip of the rock strata is toward this low area. The sloping sides of the basinlike structure include large areas in Indiana and Kentucky as well as a major portion of Illinois. The part of the Illinois Basin in which oil and gas exploration is most active at the present time is shown on the map, pages 32 and 33.

The geological environment of the Illinois Basin, characterized by considerable thickness

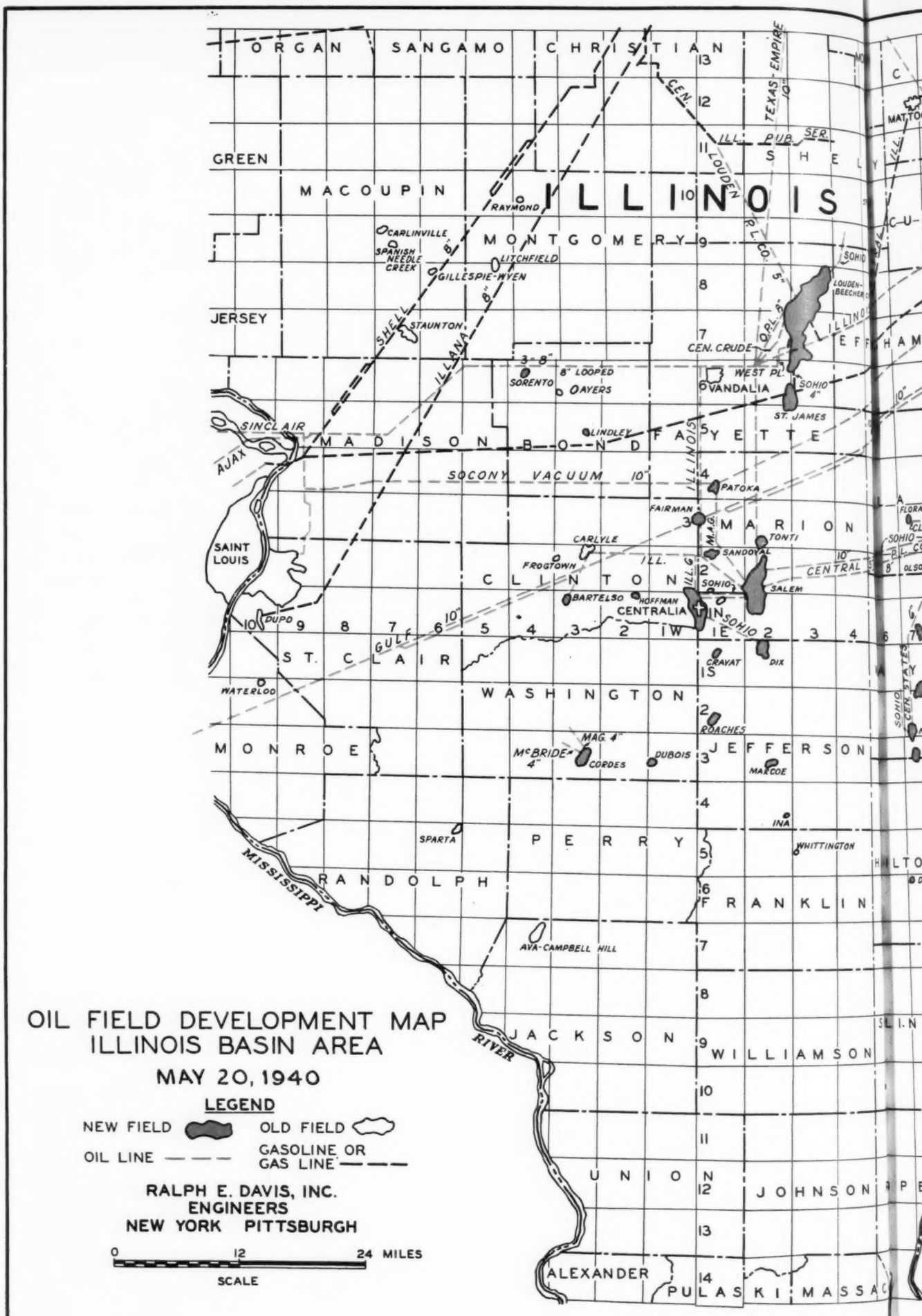
of marine sediments which have been slightly disturbed by folding, has been recognized for at least ten years as a type likely to contain important commercial reserves of oil and natural gas. As is indicated on the accompanying map, large oil producing areas designated as old fields had been developed in the past and a considerable number of new fields in other parts of the area have been developed recently. The depth of wells, the character of the production, the recoverable oil reserves and many other problems concerned with the exploration and exploitation of the area are dependent largely on geologic factors. For that reason the discussion of the questions with which we are primarily concerned will be preceded by a brief resume of the geology of the area in order to provide a proper background.

The greater part of the Illinois Basin is covered with glacial drift and recent stream deposits. Consolidated rocks deposited near the end of the Pennsylvanian coal measures forming time, and, in marginal portions of the Basin, older rocks, outcrop in limited areas. Beneath the surface rocks variable thicknesses of the Pennsylvanian coal measure series are found in the central part of the Basin and including most of the area shown on the accompanying map. This series of beds, which may have a thickness of 2,000 ft., was deposited during and after the development of many of the local folded structures which have been important in causing the accumulation of oil and gas fields. Consequently in most parts of the area the presence of favorable structural conditions is reflected in the surface formations only imperfectly, if at all.

Left, section of Pure Oil Company's Clay City field showing the 20 acre well spacing program in use: Below, an early lease bordering an Illinois cemetery.

Underlying the Pennsylvanian coal measures are the sandstones, limestones and shales of the Chester series of upper Mississippian age. The thickness and character of the formations making up this series varies considerably over various parts of the Basin; the most important changes affect the thickness and character of the various sandstones. The entire series generally has a thickness of 500 to 1,000 ft., but is nearly 1,500 ft. thick in the deepest part of the Basin. Although at least one of the sandstones of the Chester series usually has been found productive in any important field in the Illinois Basin the productive sand occurs in first one part and then in another part of the series so that although not more than three Chester sands have been found thus far to be productive in any one field, oil production is obtained from seven sands of the Chester series in the Basin area.

Beginning with the top of the lower Mississippian formations the character of the strata underlying the Illinois Basin area changes markedly and instead of being composed dominantly of shales and sandstones with minor limestones the dominant rock material is limestone. Shale and minor thicknesses of sandstone occur also at various horizons. Oil production is obtained from these lower beds in the McClosky and St. Louis limestones near the top of the lower Mississippian and in the upper part of the Devonian limestone some 1,400 to 1,500 ft. deeper. Exploration of the formations below the St. Louis has thus far been restricted to a few wildcat wells and to wells drilling for production from the Devonian limestone in the various fields of the Centralia district. Nevertheless information obtained from outcrops of these formations around the margins of the Basin, supplemented by cores and other information from wells in the Basin, leads to the conclusion that in addition to the Devonian limestone there are other prospective producing formations below the St. Louis limestone which must be tested on favorable structures in various parts of the Basin area before exploration can be considered complete. Apparently the most promising formations listed from top to bottom are the Salem limestone, the Carper or Kinderhook sandstone, the basal Devonian sandy zone, the Silurian dolomites, the Trenton limestone and the St. Peter sandstone. It is impossible to predict which of these formations may prove to be the most important and indeed to state definitely that new important production will be found in any of them, although oil is now being produced in some



OIL FIELD DEVELOPMENT MAP
ILLINOIS BASIN AREA

MAY 20, 1940

LEGEND

NEW FIELD — OLD FIELD

OIL LINE — GASOLINE OR GAS LINE

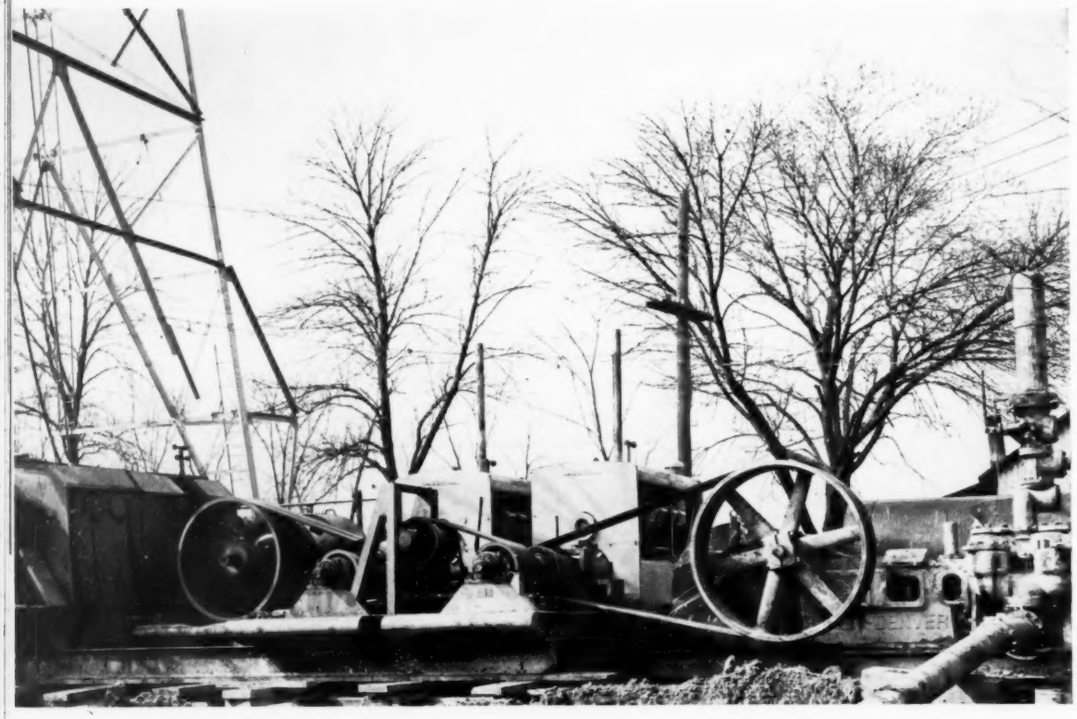
RALPH E. DAVIS, INC.
ENGINEERS
NEW YORK PITTSBURGH

0 12 24 MILES
SCALE

INDIANA
KENTUCKY
COLES
EDGAR
CLARK
CUMBERLAND
CRAWFORD
JASPER
RICHLAND
LAWRENCE
JEFFERSON
WAYNE
EDWARDS
WABASH
WHITE
HAMILTON
HAMILTON
GALLATIN
HARDIN
POPE
VIGO
CLAY
PUTNAM
OWEN
SULLIVAN
GREENE
KNOX
DAVIESS
MARTIN
GIBSON
PIKE
DUBOIS
WARRICK
SPENCER
PERRY
POSEY
VANDERBURG
HENDERSON
UNION
WEBSTER
McLEAN
HOPKINS
MUHLENBURG
CRITTENDEN
LIVINGSTON
HANCOCK
OHIO
WARRENTON
MATTOON
WESTFIELD
SIGGINS
MARTINSVILLE
PRAIRIE CREEK
RILEY
SIOUX
MARTS
SHELBURNE
DODDS BRIDGE
BELLAIRE
MAIN
KIBBIE
MEROM & RALEY
NEW LEBANON
OBLONG
ROBINSON
FLAT ROCK
HARDINVILLE
PARKER
OAKTOWN
DUNDAS
NUTTALL
APPLEGATE
BIRDS
RUSSELLVILLE
OLNEY
LAWRENCEVILLE
VINCENNES
BRIDGEPORT
MURPHY
DENNISON
NOBLE
S. NOBLE
CLAY CITY
SCHNELL
ENTERPRISE
ALLENDALE
CISNE
MT. ERIE
BOYLESTON
MT. CARMEL
KEENSBURG
E. KEENSBURG
W. PRINCETON
GRIFFIN
BARNHILL
GOLDEN GATE
N. ADEN
ADEN
LEECH
GRAYVILLE
COWLING
HESTON
MILL SHOALS
BURNT PRAIRIE
SPRINGERTON
CALVIN
PHILLIPSTOWN
NEW HARMONY
DALE
STOKES
IRON
STORMS
HEUSLER
POINT
JUNCTION
CORYDON
NIAGARA
GILMORE
OWENSBORO
GLENVILLE
N. UTICA
UTICA
SEBREE
LIVERMORE
ASHLAND
MAGAN
AMBROSE-WELLER
NARROWS
REED
SPOTTSVILLE
BIRK CITY
THRUSTON
NANTZ
CLOVERPORT
ROCK HILL
ST. WENDELLS
VIENNA
VANDERBURG
GENTRYVILLE
SANTA CLAUS
BRISTOW
BIRDSEYE
TRI-COUNTY
OAKLAND CITY
FRANCISCO
W. FRANCISCO
OATSVILLE
BOWMAN
HARMON
ALFORD
HUDSONVILLE
VEALE
MONROE CITY
LOOGDOTEE
CANNELBURG
SHOALS
FLORA
E. FLORA
SOHIO P.L. CO.
CEN. STATES P.L. CO.
SOCONY VACUUM
GULF
SHELL
WABASH
ILLINOIS
K.N.G.
RFG.
10"
8"
6"
3"

part of the Basin from all of them except the Silurian dolomite and the St. Peter sandstone.

The general basinlike structure of the area has been modified in many places by anticlinal folding and in the south by faulting. The LaSalle anticline, a regional fold along which the old eastern Illinois fields are situated, and the DuQuoin anticline on which the fields of the Centralia district are situated, have been known for more than 25 years. The west slope of the LaSalle anticline, and the east slope of the DuQuoin anticline are comparatively steep and bound the deep part of the Illinois Basin.



Portable outfit used in the first rush of drilling at Centralia.

Data obtained during the recent oil development indicates the presence of other anticlinal trends along which local structures causing the accumulation of oil and gas occur from place to place. The most important of such trends discovered thus far are the Louden-Salem-Dix trend, the Cisne-Clay City-Boos trend and the southwesterly trend from Wabash County across White County, Illinois. Numerous minor structural features and perhaps other major anticlinal axes are present and remain to be discovered. The major faults of the region are related to the Rough Creek fault of west central Kentucky and the Shawneetown fault in Illinois, and have a general east-west trend. In some parts of the general faulted zone minor faults are numerous and trend in various directions. At present, at least, in so far as Illinois itself is concerned, the prospects of satisfactory oil production in this general structural zone do not appear to be as good as elsewhere.

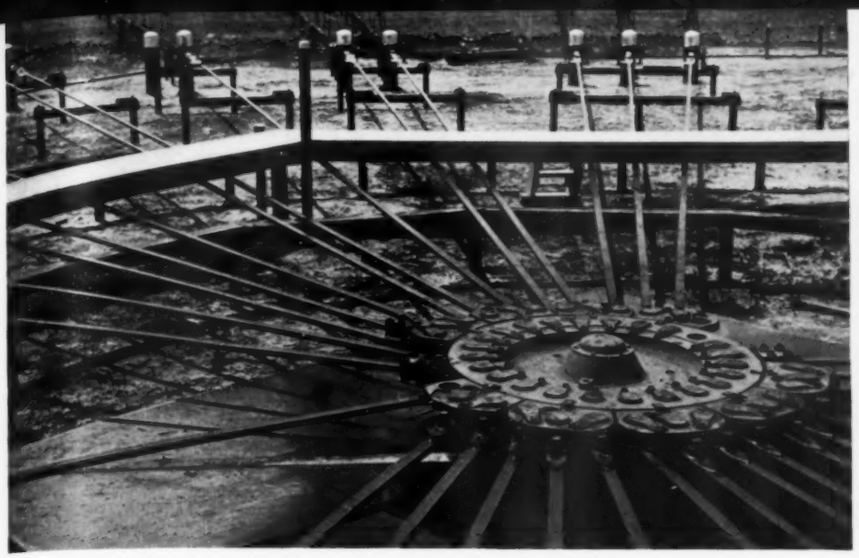
The accumulation of oil and gas in the fields of the Illinois Basin area is largely controlled by the presence of anticlinal structures. Although the reservoir conditions are rather uniform, in so far as the sandstones are concerned in the Salem and new Centralia fields, the structural control of production is modified to some extent in the other fields by variations in the character and thickness of the productive sandstones. Conditions of this type are particularly important in the oil fields of southwestern Indiana and northwestern Kentucky, in Wabash County, Illinois and in the unimportant old production in Randolph County, Illinois. Developments in the new fields are serving to emphasize the importance of sand conditions, particularly in the fields located in Illinois and Indiana along the Wabash River.

The occurrence of proper porosity and permeability in the various limestone reservoirs is likewise important. Certain area limitations of satisfactory conditions in both the Ste. Genevieve and Devonian limestone are suggested by data from the results of drilling to date. Satisfactory reservoir conditions in the Ste. Genevieve, for example, appear to be restricted to the area east of the DuQuoin anticline and southeast of a line running from Centralia to the northeast corner of Jasper County. There is evidence likewise suggesting that in the deep portion of the Basin the Devonian limestone may be too dense and impermeable to serve as a satisfactory reservoir rock, for tests properly located on local structures there have failed to produce. The scientific investigations being conducted by the Illinois State Geological Survey with the cooperation of the oil operators doubtless will make important contributions to the solution of these broad general problems during the coming months.

In considering the prospect of discovery of additional oil reserves in the Illinois Basin area there are several factors which should be kept in mind. First, the seismograph has been the most commonly employed geophysical method. Since data obtained by this method serve to locate anticlinal and other structural features, oil and gas fields which have accumulated primarily as a result of structural conditions will be readily discovered in most parts of the area. Additional fields remain to be discovered through the use of the seismograph because improvements in equipment and methods are expanding the scope of structural problems and increasing the area for which the method can be used. Second, there is little doubt that untested favorable structures are present within some of the large blocks of acreage held by the major companies on which test drilling has been deferred. As their exploitation programs for the fields already discovered become less important, some drilling in these areas may be expected. Third, the initial successes in the Patoka-Centralia area on the west side of the Basin and in the Clay City-Cisne area in the central part of the Basin attracted operators to these general vicinities in the early stages of development work. More recently exploration has been undertaken farther south and east with the result that important fields have been discovered in the Illinois and Indiana counties bordering the Wabash river and in northwestern Kentucky. Recent discoveries in this portion of the Basin are expected to increase the interest and activity of the oil operators in an area east of the low portion of the Basin. Fourth, additional fields not situated on anticlinal structures also remain to be discovered. Their discovery will follow careful interpretation of well data and exploratory drilling, or possibly, as was the case in the East Texas field, the chance choice of a proper well location by a wildcatter. Data now available suggest that both the Chester sandstones and some of the lower formations are likely to produce under such conditions. Such fields, in contrast to multi-sand fields on pronounced structures, are unlikely to prove productive in more than one formation.

An interesting future for the oil producing industry in the Illinois Basin may be confidently anticipated as a result of the conditions described. The large size of the inadequately explored area and the considerable number of potential producing formations remaining to be tested insure a considerable period of exploration. The probable location and character of these fields is uncertain but some general predictions regarding them based on available information may be made at this time.

It is probable that an important part of the oil reserves remaining to be discovered are in formations now producing and in the part of the Basin east of the DuQuoin anticline. In most parts of this large area known structures are of modest extent, in many cases less than 1,000 acres in the area. Yet many areas as large as a township have been tested by only



World's largest central pumping power with 15 miles of rod lines, operated by Pure in southern Illinois: Right, a light rig in Centralia.

one or two wells penetrating the entire Chester series. In most cases there is considerable question that these wells were properly located with respect to local structures. Obviously additional drilling is required for adequate testing of such areas. If the results of drilling up to the present time may be used as criteria for estimating the future of this area additional fields of importance may be anticipated.

Few fields in which the accumulation of oil has taken place primarily as a result of stratigraphic conditions have been discovered during the recent development program in the Illinois Basin. At the same time as more well data provide better information regarding the changes in thickness and in character of the sandstones of the Chester series the likelihood of the discovery of such fields becomes increasingly clear. Prospects of such discoveries are indicated for parts of the Basin proper and in particular appear interesting for the area immediately west of the oil fields in eastern Illinois extending from northwestern Lawrence County in a northwesterly direction to the vicinity of Mattoon. Accumulation of this type in the Devonian limestone series is also possible in the area south of Decatur and north of the limit of the map included herewith. The Devonian formations according to recent interpretations of well samples have been removed by erosion at Decatur and yet are known to be present some distance to the south. Accumulation may have taken place as a result of a stratigraphic type of trap in the intervening area.

The prospects for the discovery of additional oil fields in formations below the McClosky are imperfectly known at the present time. The St. Louis and Salem limestone are likely to prove productive in other areas but the amount of drilling necessary to determine the location of areas in which these formations have satisfactory characteristics may be excessive. Similarly it is anticipated that additional fields will be found in the Devonian and Ordovician strata after a considerable amount of additional exploration. The important production from the Devonian in the Salem and Centralia fields has stimulated interest in the discovery of other areas producing from this formation so that the necessary drilling will probably be undertaken. It is probable that in addition to the area in Central Illinois where production is now obtained from the Devonian, new productive areas will likewise be found on the east side of the Illinois Basin in the vicinity of previously discovered Devonian fields in southwestern Indiana. It is also probable that with the aid of the seismograph for locating tests on proper structural features the discovery of such fields will be facilitated.

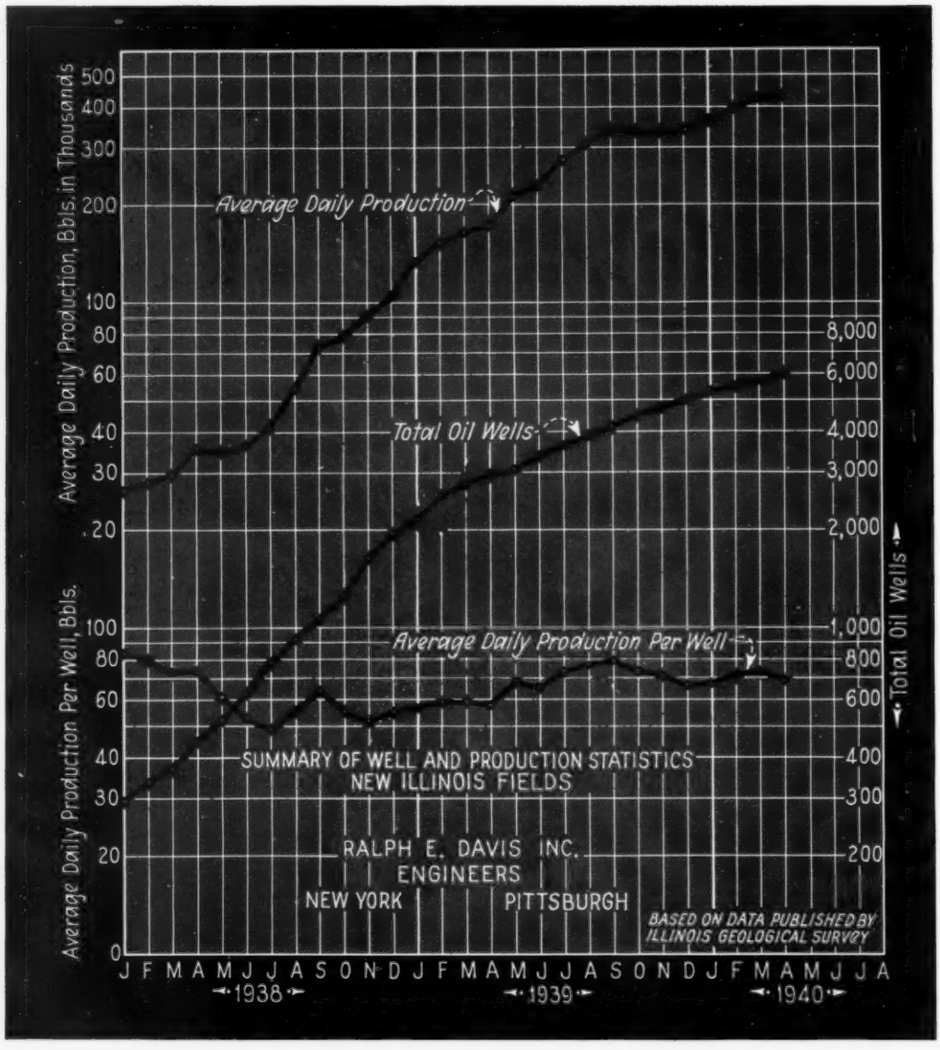
The prospects of discovering additional reserves in the deeper formations are uncertain and in so far as the Trenton limestone is concerned are probably best in marginal portions of the Basin where drilling depths are not so great. Although it is premature to make any forecast regarding the possibility of production in the St. Peter sandstone it is evident that the results of tests of this formation to date are distinctly discouraging for some of these tests were located in favorable structural situations and failed to produce.

Present estimates of the recoverable oil reserves of the field in the Illinois Basin are necessarily tentative. Reserve estimates are properly restricted to those formations actually known to be productive in each field and to the area for each field which may reasonably be considered proven by development. In the preparation of the estimates of the original reserves of the producing formations in each field use has been made of a considerable amount of detailed information for certain representative properties and of production decline data for some of the areas discovered in the early part of the current development program. In the newer areas reserve estimates have necessarily been based on the thickness of the productive sand and the area of the field modified to some extent by the producing character of the wells in so far as the sandstones of the Chester series are concerned. Estimates of reserves in areas where production is obtained from the Ste. Genevieve or McClosky line are based on rather general factors of recovery per acre as modified by local conditions. The effect on the ultimate recovery of pressure maintenance through the injection of gas into key wells is uncertain at the present time but it seems reasonable to assume that a substantial increase in the ultimate oil recovery will result from this type of operation.

An estimate was made in accordance with the above procedure for each of the fields discovered in the Basin area. The total production was then deducted from the sum of these estimates and the remainder taken as the present reserves. In accordance with this procedure the reserves of the Illinois Basin fields as of June 1, 1940, are estimated to be in excess of 525,000,000 bbl. About 75 percent of these reserves are in the fields developed along the western side of the Basin. The remaining reserves are present in numerous fields in the central and eastern part of the Basin including the old eastern Illinois fields and the southwestern Indiana-northwestern Kentucky areas.

The question of the probable rate of oil production in the Illinois Basin area is of more importance to the industry as a whole than the amount of oil which will be ultimately produced. The daily rate of production will depend to a large extent upon several factors any one of which may be decisive. First, the maintenance of the present rate of production of more than 430,000 bbl. per day will depend upon the discovery of additional producing areas and the extension of present known fields. Second, the future rate of production will depend to some extent on the availability of facilities for transporting the oil to market. Third, the future rate of production will depend to a large extent on the policy of some of the major oil companies in the absence of state oil proration laws and on the terms of such laws when and if passed.

More than 6,500 oil wells have been completed in the new Illinois Basin fields, and for that reason a considerable degree of stabilization of production has been obtained. A better appreciation of this situation may be



obtained through a simple statistical study. The best information on monthly production and wells is available for Illinois in the monthly reports of the State Geological Survey. A summary of these statistics is given in graphic form herewith. As shown by the graph, in January 1938, when little was heard of the market threat of the Illinois production the average daily production per well was one-seventh greater than in April 1940. The daily average production per well declined gradually during 1938 from nearly 84 bbl. per day in January to a low point of 48.6 bbl. per day in July. Thereafter simultaneously with the start of the development of the Salem field the daily average production per well showed an increase but fluctuated from month to month between 51 and 63 bbl. per day until the end of April 1939. During the last three months of 1938 more than 1,000 of the 2,000 oil wells completed in Illinois during the year were brought in and consequently the newly completed wells were a very important factor both in the rate of production for the state as a whole and in the average production per well. Since the first of May 1939 the average daily production per well has had a limited range from slightly less than 65 bbl. to slightly more than 76 bbl. During this year more than 3,000 producing oil wells were completed so the production of the state as a whole increased considerably as shown by the graph.

The figures cited serve to demonstrate the importance of continued drilling and discovery and development of new producing areas to maintain the average daily oil production of the Illinois Basin area. It is not clear that a substantially increased rate of production is to be anticipated in the near future but it likewise seems probable that with the large number of producing wells and the extensive program of new drilling now in progress an important reduction in the daily average production of the state is unlikely to occur soon.

It is probable that in recent weeks there has been an important limitation of output for the Illinois Basin fields as the result of the limited capacity of pipeline facilities for moving oil from the area to markets. The interest of pipeline companies in expanding these outlets will depend on various factors. The discovery of additional new fields with important reserves would justify the construction of additional facilities and might cause this construction to be undertaken. However, Illinois Basin production has been supplying more than 50 percent of the quantity of oil refined in the central and Appalachian refining districts since the first of 1940. In recent weeks a considerable amount of Illinois Basin oil apparently has been shipped across the lakes to Canadian markets and has displaced oil produced in Texas formerly supplying them. Under these conditions there may not be any important additional markets available for Illinois Basin oil.

The construction of additional pipeline facilities may depend in part on the European war. If it should become reasonably certain that the war will be of long duration the construction of additional pipeline facilities from Illinois to the Great Lakes and the East could be economically justified. Under wartime conditions the demand for tankers and the loss of tankers is so great that the shipping rates by sea from ports on the Gulf of Mexico to the refining centers of the Eastern Seaboard have increased very materially. To the extent that oil and refined products from oil brought in by tankers is transported by pipeline to refining centers not on tidewater it might be cheaper to take Illinois Basin oil by pipeline to these markets. In the case of a long war ocean freight rates from the Gulf Coast ports to the Eastern Seaboard might be increased further with the result that the economic position of the fields of the Illinois Basin would be further improved with respect to large parts of the eastern market.

Considerable publicity has appeared concerning the wasteful operating methods in the fields of the Illinois Basin. It is true that an excessive number of wells has been drilled in parts of the Salem field and in Town Lot sections of other fields, notably Centralia and Patoka. It is also true that excessive amounts of gas have been produced with oil and wasted particularly in the Centralia, Salem, Clay City and Storms area. These facts tend to develop a mental picture of universal over-production from large capacity wells under wasteful conditions. Although this conclusion is true for portions of the Illinois Basin fields it is likewise true that rigid conservation is practiced in many of the fields. A broad view of the situation is needed properly to appraise the situation as a whole. This can be obtained most readily through an examination of production statistics. They show that the daily average production during April 1940 in the new Illinois fields was less than 70 bbl. per well for the 6,200 wells. As a consequence of the large number of producing wells the unrestricted production from a few wells of large capacity has only a minor effect on the average for the area as a whole. Likewise the inevitable rapid decline in output of such wells will not be conspicuous at the present time. Such operations are characteristic of portions of the Centralia and Salem fields but are less important in other areas.

Less prominent news items describing the advanced methods of exploitation have likewise appeared but have received relatively

little attention. There has been voluntary restriction of production in many of the fields, most notably in the Louden-Beecher City area, but also in parts of the Salem, Centralia, Dix and other newly discovered fields. It is for that reason that the policy of the few major operators practicing proration in the absence of any legal requirements under state law will be of considerable importance in determining the daily rate of production.

The most nearly complete proration and conservation program is in effect in the Louden-Beecher City field. Most of this area is being exploited by one operator and the pressure maintenance project has been in operation for more than one year. Systematic spacing of producing wells and gas injection wells and the limitation of production to the amount of gas which the compressing equipment is able to reinject into the producing formations has prevented any appreciable reduction in pressure in the oil producing formations. Consequently it may be presumed that the rate of production of the wells still approximates their initial rate. The average initial production of the wells completed in this field during the first four months of 1940, which may be considered as representative, was slightly in excess of 200 bbl. per day. The average production of wells in the field early in May 1940 was less than 50 bbl. per day per well in spite of the fact that approximately 10 percent of the wells in the field were operated at their maximum capacity. It should be noted that in a field of this size the difference between the present rate of production under restriction and the potential production is approximately 200,000 bbl. per day. Because a similar situation prevails in portions of the Salem and Centralia fields and in the Dix field the policy of the companies operating these properties will have a very important bearing on the future rate of production for the region.

The policy of major operators regarding the development of essentially proven acreage which has not yet been drilled will likewise have an important bearing on the future rate of production. There is no question that should it appear to be to the advantage of these companies they could accelerate their development program substantially thereby making an important increase in their potential production.

The present rate of production from the oilfields of the Illinois Basin of nearly 150,000,000 bbl. per year would obviously deplete the estimated reserves in the present fields in a little more than three years. For that reason it is clear that the duration of the present importance of the region will depend on the continuing discovery of additional reserves both in deeper formations in present producing areas and in new fields. There is no satisfactory basis for speculation as to length of the period during which new reserves will be discovered at the rate of 12,000,000 to 13,000,000 bbl. per month. At the present time, however, discoveries seem to be continuing at about the same rate as production and there is no apparent reason for believing that additional discoveries at this rate will not be made for some months in the future. Probably the most important factors in determining the short term trend of production will be the outcome of tests of the Trenton limestone now being drilled in the Centralia district and of the tests of the Devonian limestone being drilled and scheduled for drilling in the old eastern Illinois fields. The longer term trend will depend largely on the success of exploratory drilling in the southeastern Illinois-southwestern Indiana area, and particularly in the success of attempts to discover commercial oilfields in lower Mississippian and older strata. Many additional wells must be drilled before the final outcome can be determined.

In conclusion it is clear that the future development of the Illinois Basin may be awaited with considerable interest for large potential oil producing areas are at present inadequately tested. The daily rate of production will depend largely on new discoveries, pipe line outlets and the policy of certain major oil companies. The life of the region as an important source of oil production will depend almost entirely on the discovery of additional reserves in deeper formations and in new producing areas. Although it is evident that additional discoveries may be confidently anticipated their continuing adequacy to replace the oil being produced at a rate in excess of 12,000,000 bbl. per month is not at all certain.

ILLINOIS Oil A Receding Menace

With Production Approaching More Settled Stage and Volume of Cut Price Sales Subsiding Industry Feels That Threat to Stability is Lessening - Conservation Issue Still Undetermined.

Oil production in Illinois appears to have reached a settled basis, for the time being at any rate. For nearly three years after the original discoveries in 1937 the state's oil industry underwent a hectic development. New fields were opened, new wells were drilled and new horizons discovered in such rapid sequence that estimates of potential output and reserves had to be revised almost from week to week. While a number of large producing companies were in the play almost from the beginning small operators formed the great majority, their activities being favored by the preponderance of small land holdings.

The drilling scramble, particularly in the Salem field, exceeded anything that had taken place since the early days of East Texas. Production rose from 150,000 bbl. at the beginning of 1939 to 200,000 bbl. in May and to 300,000 in September. In February 1940 the 400,000 bbl. mark was passed and the daily average for the month of March was 438,000. Since then production has held rather steadily around 420,000—430,000 bbl.

With each successive rise in production predictions were made that the fields were near their peak. When yields were in the neighborhood of 200,000 bbl. daily it was confidently asserted that they would not exceed 250,000 bbl. Later estimates were raised to 400,000 to 500,000 and more recently to 625,000 as each of the smaller figures was surpassed in actual performance.

It would be rash to make positive statements in the light of past experience, but there seem to be indications that Illinois fields have entered a more settled position and that a reappraisal of their physical and economic possibilities may justifiably be attempted. Such a survey, prepared by a well known geologist who has spent much time in a study of the area, is presented on foregoing pages of this issue.

The rapid increase in output which has carried Illinois to a place among the leading producing states is not the only development that has made its rise of sensational interest to the oil industry. Its effect upon previously established channels of distribution and its influence upon the marketing situation in one of the country's important consuming areas has been proportionately more sweeping even than its rise in output.

The location of Illinois fields in relation to the central marketing area, with refineries having a capacity of over 500,000 bbl. daily within a near radius and with through pipelines from the Mid-Continent crossing the state, is one of great strategic advantage. In the haste of individual operators to pay out as quickly as possible Illinois oil began to be offered much below posted prices and for a time it was estimated that 25 percent or more of the output was being sold at cut rates.

This influx of new and low-priced supply seriously affected the position of producers in Kansas, New Mexico and parts of Texas and to a lesser extent in Oklahoma. These producers naturally enough objected to the whittling down of their accustomed market outlets. Their special grievance was voiced in the claim that Illinois was running wild, pro-

Dowell trucks ready to acidize a well in the new southern Illinois fields.

ducing without regard to the depletion of its fields and the waste of potentially recoverable oil, while they themselves were under the restrictions of state regulation and proration.

While Illinois had been an oil producer for fifty years the state never had enacted a strong conservation law and until recently had never felt the need of it because of its limited output. With the expansion of its output, however, and the increasing pressure of its price competition the agitation over the question of conservation became an issue of almost national importance and the influence of President Roosevelt and Secretary of the Interior Ickes was exerted in favor of a conservation act.

Within the state itself opinion was divided. A growing number of independent operators came to realize that overdrilling, wide open production and underselling were robbing them of returns which they might legitimately expect while those who were drilling on credit or on slender financial resources opposed any legislation that would prevent them from cashing in in the shortest possible time and property owners anxious to begin receiving royalties were largely aligned in the same camp. The major companies, through favoring conservation which they had supported in other fields, mostly remained aloof from the fray. The issue became complicated with state politics and no legislative action has been taken up to the present time.

Meanwhile the situation has been gradually adjusting itself. Voluntary measures of well spacing and preservation of bottom hole pressures have been introduced in certain fields of which Loudon is a conspicuous example. Illinois oil is finding its place in the general picture and the quantity of oil selling substantially below the posted price of $1.05 per bbl., while still considerable, has decreased to a point where it is much less a threat to market stability than formerly was the case. It is generally considered in the industry at large that the question of conservation is one for the state itself to settle with regard to its own interests.

Inside the state the issue is still very much alive with two organizations of independent producers working for a conservation law and one opposing any legislation.

The position of the Independent Oil Producers Association is set forth in the following statement given to WORLD PETROLEUM by President John Pugh:

We believe in and stand ready to fight for the right of Illinois to produce every barrel of oil that can be secured without physical waste and sold at the market price.

The market price of Illinois oil is much better and firmer now than it was last summer and fall—due largely, we believe, to the intensive campaign this organization conducted last year against physical waste, price cutting, etc. We, as independent producers feel, however, that, improved as the price situation is, we are entitled to a better price for our oil delivered to middlewestern refinery points than are southwestern and mid-continent producers, due to the transportation differential favoring us because of our proximity to these outlets.

In order that we may merit and obtain this price advantage we have advocated, and still do, more efficient and scientifically proved well-spacing; ratable take or equitable purchase by all crude oil buyers from each well in every pool or field, insuring each a fair share of the market at the posted price, and protecting landowners against undue drainage of their oil by neighboring operators.

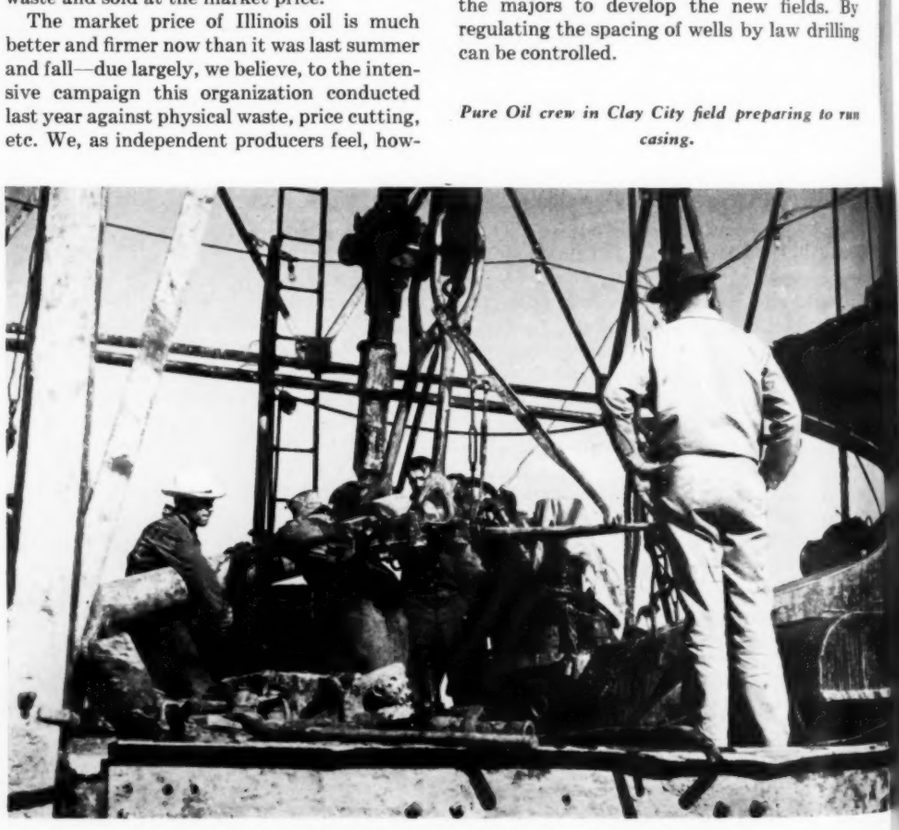
We are unalterably opposed to anything more than the minimum of state regulation necessary to correct the inequalities that now exist (wasteful drilling and pipeline proration) and avoid possible federal control of our business.

Speaking for the opponents of conservation Dorsey Hager, technical adviser to the Illinois Oil Producers Equity Association said:

The writer has been one of the leading battlers against proration in Illinois, and has carefully studied the subject in its physical, economic, and political aspects. In talking to hundreds of landowners, merchants, business men, and politicians as well as oil men, it seems that every proponent of proration, whether an individual or corporation, has a personal axe to grind. Attempts are made to make this cry of "wolf, wolf" more terrifying by claims of wanton waste in the Illinois fields, whereas, in truth, the so-called waste is less here than in many states operating under proration.

The major oil concerns control large acreages in the state of Illinois held on 10-year leases. Independent producers can find holes in such blocks and by drilling such tracts force the majors to develop the new fields. By regulating the spacing of wells by law drilling can be controlled.

Pure Oil crew in Clay City field preparing to run casing.



If proration is passed, and with it a spacing law, it will cut off the supply of oil to the independent refiner, eliminate the independent pipe line, force the independent marketer to buy from the major concerns, put the small independent producer in a position of dependence on the majors and give the latter a monopoly of the business.

The fight against this proration proposal is carried on by independent oil producers, independent pipe lines, independent refineries, and independent marketers who largely function through the Illinois Oil Producers Equity Association. Outside of this organization landowners who want active development of their properties, merchants and business men who desire prosperity to continue and those legislators who heed the needs of their constituents back up the true independents.

High-sounding pronouncements for the perpetuation of an oil supply for future generations are used by the oil control advocates as their chief argument to the public. The main argument in the past has been based on an impending scarcity of oil. This argument and with it the whole argument for federal and state control for necessary conservation falls flat under actual conditions.

No intelligent, well-posted oil man any longer believes there is any scarcity of oil from oil wells in sight for many years for the following reasons:

(1) Proven reserves are increasing. New oilfields are being found in the United States and all over the world.

(2) Deeper pay sands are being opened in nearly all the producing fields, each one equivalent to a new field. The Wilcox sand in Texas and Louisiana has opened a great future for those states, and they are merely examples of what is happening in other states.

(3) Present producing reserves are very conservative, probably 50 percent too low. The 19 billion barrel known reserves are more nearly 30 billion.

(4) Synthetic petroleum, hydrogenation of coals to form oil, increased power of oil fuels, and improved carburation supplement petroleum from the wells and will reduce the demand for oil from wells.

(5) The recent announcement of the Dow Chemical Company that it is producing a synthetic product that will care for 10 percent of the higher motor fuels is most significant. Gustav Egloff follows this by his statement that Universal Products has developed a 50 percent increase in the energy of motor fuels.

Add to this the improved carburetors being placed on the market and it is simple to see what is ahead of the oil industry.

Aside from these announcements, the United States Bureau of Mines announced a few months ago that there is enough coal to furnish us oil products by hydrogenation for two thousand years, so one can see that any ideas of an impending oil shortage are ridiculous.

Recent developments are more likely to cause petroleum to be a drug on the market. Only the petroleum near refineries and close to market will be in demand. West Texas, New Mexico and Western Kansas in the next few years will probably shut down numerous oilfields and fail to develop others as their oil simply will not be in demand. This may sound far-fetched, but no more so than what has happened in the coal industry. Coal was supposed to be vanishing rapidly in 1905, yet today there is enough coal in Illinois and Indiana to care for the nation's needs for 500 years, not to mention the great coal reserves in many other states of the Union. The real danger is the dying out of the oil business from oil wells, due to new synthetic products replacing petroleum or from increased efficiency in the use of petroleum products.

Drilling in Wayne County, Illinois.

Waste in Illinois is not a problem, as has been stated by Illinois proration advocates. Obviously, there can be no defense for waste, but it can be shown very clearly that while there is an escape of wet gas in Illinois it is relatively unimportant, not over five percent of the value of the oil produced. In Illinois the gas is lighted in flares, while in West Texas flares are a rarity, although the gas escapes. The quantity of escaping gas there is not visible, but the volume is vast. With gas-oil ratios in Illinois of from 300 to 500 to 1, as against 5,000 to 1 for New Mexico, 2,000 to 3,000 to 1 for Louisiana and 1,000 to 1 in Texas, (the last three conservation states) it is certainly sheer propaganda to attack Illinois.

No one condones wilful waste, but the greatest waste in Illinois and in the Mid-Continent is not in the escaping gas, but in the failure to drill enough wells to secure all the oil that should be obtained. A spacing of five to six acres per well would produce nearly twice as much oil as a spacing of 10 acres per well. Authorities, and practical oil men are pretty well agreed on this point.

These are the arguments used by the opposing groups. One side uses as its slogan: "There is only one oil crop in Illinois—we must not squander it,"while the other has as its battle cry, "There is a good oil crop in Illinois; let's harvest it." Meanwhile, for the industry of the country as a whole the Illinois situation appears less threatening than a year ago and it probably will remain so unless some new and startling development takes place.

RECORD DEMAND Helps To Prevent Poor First Quarter

By Henry E. Rose

ALTHOUGH the American oil industry experienced a sharp rise in profits during the first quarter of this year as compared with the subnormally poor results in the corresponding period of 1939, the outlook for the three months to end June 30, and for the remainder of this year, is clouded by:

(1) Uncertain and disturbed world economic and political conditions;
(2) An unsatisfactory statistical situation for the industry; and
(3) An unfavorable price structure for gasoline, the major product, and a softer trend for other refined products.

War-torn Europe, up to the present time, has been a decidedly adverse influence on the American industry, and, to a large measure, this has had a repercussion on the other two factors mentioned; namely, the statistical situation and the price structure. Rationing schemes throughout Europe and the United Kingdom, together with higher taxes and increased prices, cut U. S. exports sharply in the first three months of this year. Crude oil shipment, for instance, were 19 percent less and refined products 24 percent smaller, than in the similar period of 1939.

The off-shore movement of gasoline, the most important refined product in the oil export trade, was curtailed 40 percent in this year's three months. It averaged slightly more than 2,000,000 bbl. monthly against almost 4,000,000 bbl. during all of 1938, the pre-war year. April and May have not shown any improvement according to preliminary estimates. Only lubricating oils and wax are moving out in larger quantities than a year ago, and here, too, in recent months there has been a slowing down.

While recent developments in the European war—the expansion of mechanized operations on a major scale into neutral countries and sharply intensified activity—indicate enlarged consumption of oil products, it is difficult to discover among the principal exporting companies any substantial support for the belief that the United States will obtain a material part of this prospective business. The Allies, it is re-emphasized, are reluctant to purchase in this country while the foreign exchange position is adverse; and further, they prefer to deal in countries where they can obtain credits and thus conserve their liquid financial resources as long as possible.

It is also pointed out that from the standpoint of the time element involved, supplies could be gotten more advantageously from Venezuela and the Dutch West Indies because sea distances are cut several hundred miles as compared with the American gulf. Tanker deliveries, thus, could be materially expedited. Any improvement in demand from Europe, of course, would assist in correcting the unhealthy inventory position of gasoline.

Meanwhile, domestic consumption of principal products and the refining of crude oil are at new record levels. The industry, however, has geared its operations far in excess of this larger demand, and the normal seasonal influences on stocks — withdrawals of gasoline for example—are not being realized. This, too, despite the fact that the industry at the end of the period of accumulation—March 31—had built up an unprecedented inventory in excess of 101,000,000 bbl., or some 15,000,000 bbl. higher than a year earlier when a topheavy position prevailed.

The effect of these inventories has been an almost nation-wide contra-seasonal price trend for this major product. On May 1 the average dealer price in 50 representative cities, before taxes, was at the lowest level in years. Further reductions since then have lopped an additional fraction from the average.

As of May 1 the American Petroleum Institute calculated the dealer price average at 9.24 cents a gallon, a reduction of .21 cent from a year ago, and .54 cent as compared with January 1, last. The 1939-1940 high was 9.87 cents on November 1, last, from which time the downward swing has been uninterrupted. The service station price, before taxes, averaged 12.91 cents a gallon on May 1, the lowest since January 1, 1935, and compared with 13.16 cents a gallon a year earlier.

For the fully integrated oil companies, this price in relation to crude oil costs, which have been unchanged since October, 1938, is of prime importance. It affects both refining and marketing operations for the industry's principal product.

As for crude oil, the industry has been overproducing this commodity since last November. There have been some indications that corrective measures will be taken this month (June), especially by Texas which has been responsible, in recent months, for excesses as high as 200,000 to 300,000 bbl. daily. Only a part reflection of overall excess production is evidenced in stocks of crude oil above ground. A substantial part is concealed by high refinery operations and is found in increasing refined products inventories, especially gasoline.

Crude oil stocks above ground hit an eighteen-year low in November last, around 230,000,000 bbl. As of a recent date they approximated 260,000,000 bbl., and were within 8,000,000 bbl. of the level early in August, 1939, just before the unprecedented shut-down of oil wells in six southwestern states to avoid a reduction in the price of Mid-Continent crude oil. That shut-down caused a depression in stocks.

The building of these inventories recently, together with heavy gasoline stocks and abnormally high refinery operations, is not conducive to maintenance of a sound price structure. If these conditions persist, it is certain that they will be reflected in price adjustments ultimately.

Refinery operations of the industry in recent months have been well in excess of economic requirements, and at record levels. The necessity for accumulating heating oil inventories for the 1940-1941 winter season is partly a factor in these runs, however, and will disturb the balance between gasoline and heating oils unless the industry adjusts its refineries for a larger yield of the latter than has been the case in recent years. It was the failure of the industry to increase such yields last year which largely accounts for the present high inventories of gasoline. And, if yields are not stepped up this year, the industry should be prepared to face a more serious situation on gasoline in 1941.

Since these economic phases have so vital a bearing on financial operations, it is deemed advisable to devote a little more space to them than under ordinary circumstances. Their continuance, with no corrective action by the industry, or by state regulatory bodies in connection with crude production, will be reflected in income accounts sooner or later.

The profit results for the industry for the first quarter, as a whole, were the best in several years and sharply higher than in the same period of 1939. Moreover, the improvement was fairly widespread. The most important gains were recorded by integrated companies with a substantial stake in fuel oil for which there was an unprecedented demand at materially higher prices.

Companies also derived benefits from sharply improved prices for lubricating oils in the period, a carryover from the demand which developed in the final months of 1939, both from industry and from abroad. With the diminution in demand for the latter, however, and stocks re-accumulating, lower prices have ruled in recent weeks in important refining centers, and profit margins, hence, have been curtailed. Moreover, in important eastern consuming territory the price of heating oil has been lowered since the beginning of May and here, too, the profits are smaller, aside from the fact that the demand at this season is practically nil.

Because of these developments—lower prices for lubricating oils and gasoline and curtailed demand and reduced prices for fuel oil—it is increasingly evident that the industry's profits in the three months to end June 30 are likely to reflect sizeable curtailment from the first quarter's results.

By types of companies, and geographical locations, however, there are exceptions. The solely producing companies and those integrated companies with greater production of crude oil than they require (Continental, Skelly and Phillips), are likely to be in a somewhat better position than integrated units which purchase a substantial share of their crude requirements.

During the first three months of this year

income accounts of 22 companies showed net profits of $43,537,452 against $13,196,867 in the similar period of 1939 (four had deficits in 1939), an improvement of 230 percent. Taking only the eighteen companies which reported profits in both years, the figures would be $39,606,352 for 1940 against $13,555,795 for 1939, an improvement of 190 percent.

In an analysis of the income accounts, it is disclosed that such companies as Atlantic Refining, Shell Union and Tide Water Associated, having heavy stakes in the fuel oil business, scored substantial gains. Texas Corp., which has large crude production in Illinois and thus enjoys an advantage of about 25 cents a barrel as compared with the mid-continent, also registered startling improvement.

The accompanying tabulation shows net profits of the 22 companies for the first quarter of 1940, with comparisons for 1939 (four had deficits):

Comparative Net Profit First Quarter 1939-1940

	Three Months Ended March 31, 1940		Three Months Ended March 31, 1939	
	Net. Inc.	A Com. Share	Net Inc.	A Com. Share
Amerada	$ 459,421	$ .58	$ 319,761	$ .41
Atlantic Ref.	3,122,916	1.12	538,453	.15
Barnsdall	357,737	.15	565,417	.25
Continental	1,380,434	.29	721,423	.15
Houston Oil	478,503	.31	403,442	.24
Lion Oil & Rfg.	171,096	.39	(d) 11,819	....
Mid-Continent	1,454,678	.78	(d) 37,957	....
Ohio Oil	2,292,294	.27	(d) 297,552	....
Panhandle Prdcg. & Rfg. (a)	13,032	...	(d) 11,600	...
Phillips	3,286,620	.74	1,485,553	.33
Plymouth	586,441	.56	619,762	.61
Quaker State	291,116	.31	277,206	.30
Richfield	947,550	.24	519,043	.13
Seaboard	502,949	.40	401,051	.32
Shell Union	5,314,158	.37	478,266	.01
Skelly Oil	773,281	.68	239,080	.14
S. O. Cal.	4,534,623	.35	3,226,016	.25
Superior Oil	44,544	.03	16,146	.01
Texas Corp. (b)	12,800,000	1.18	1,250,000	.12
Texas Pac. Coal & Oil	179,691	.20	206,359	.23
Tide Water	3,780,220	.50	1,234,182	.11
Union Oil	766,148	.16	1,054,635	.23

(a) Before federal taxes. (b) Officially estimated.
(d) Deficit.

With reports of all principal oil companies for 1939 now available, the profits for the industry ran slightly ahead of 1938, but 43 percent less than in 1937, the record high. For 23 American companies, whose shares are listed on leading securities exchanges, net profits aggregated $341,134,880 in 1939, equal to $1.78 a share of their combined outstanding common shares, after preferred dividend requirements. This compared with $324,717,742 earned by these identical companies in 1938, the equivalent of $1.70 a common share, and with $607,423,900 in 1937, equal to $3.20 a common share.

Profit showings of individual companies are mixed; 12 reported gains and 11 reductions. Among the latter were the solely producing companies — Amerada, Barnsdall and Seaboard. These companies were influenced by sharp curtailment, especially the fifteen-day shut-down of wells in six southwestern states during August, and by lower average prices as compared with 1939. Humble Oil & Refining Co. also was included in this category, although its results were affected, too, by a smaller return on pipeline operations last year.

California companies—Standard of California and Union Oil—were in the group reporting smaller income for last year, a reflection largely of lower prices and inventory accumulations.

Of the large companies with substantial foreign interests, Socony-Vacuum had a 15 percent reduction in net profits for 1939, a large part of it caused by curtailment in foreign business in the final months of the year because of the European war. Standard Oil Co. (N. J.) and Texas Corp., on the other hand, came through with improved profits.

An outstanding gain in profits was reported by Standard Oil Co. of Ohio—almost 200 percent compared with 1938—and the best showing in seventeen years. It was principally due to capital expenditures in recent years, making possible the purchase and gathering of practically all its crude oil requirements directly from producers in northern fields of Illinois, Kentucky, Indiana, Ohio and Michigan. Pure Oil Co., whose profits were about 60 percent higher, also benefitted from Illinois' crude supplies as well as from capital expenditures for refinery improvements in recent years.

The working capital position of the 23 American companies was unimportantly changed during 1939. Their aggregate working capital was $721,993,350 as of December 31, last, compared with $733,313,736 a year previously. Socony-Vacuum had a reduction of $16,000,000 during 1939 (based on revised figures for 1938 in connection with the non-availability of reports from certain European companies during 1939), all of which, and more, found its way into capital assets.

Standard Oil Co. of California, Shell Union, Union Oil, Barnsdall, and Ohio Oil, reflecting borrowings from banks or proceeds from sales of other securities, increased their working capital. Phillips Petroleum paid off a substantial part of its fixed indebtedness during the year and had a sizeable reduction in working capital.

Twenty of the 23 American companies had funded as long term debts at the end of 1939 aggregating $922,310,297. Only 18 had such liabilities a year previously in an amount of $855,549,194. At the end of 1937, when these debts were probably at a low for many years, they aggregated $628,150,432 for sixteen of the 23 companies. During 1939, Ohio Oil Co. and Standard Oil Co. of California were added to the list incurring such indebtedness.

Ohio Oil Co. disclosed borrowings of $18,000,000 at the year-end which, by February 1, 1940, had been cut to $14,000,000. Early in March it refinanced the latter amount (3¼ percent debentures) by the sale of a similar amount of 2¼ percent serial bank notes maturing over a ten-year period.

Standard Oil Co. of California, last August, made arrangements to borrow $25,000,000 and this sum was shown outstanding at the end of 1939.

Other changes which took place in fixed debts last year, the majority of which were detailed in an earlier issue of this publication, comprised an increase of $40,000,000 by The Texas Corp.; $20,000,000 by Union Oil Co. of California; $2,600,000 by Shell Union Oil Corp. and $2,575,000 by Barndall Oil Co. Gulf Oil Corp. showed a reduction of $25,000,000, one of its subsidiaries purchasing, out of current funds, that amount of 10-year 2⅜ percent instalment notes issued by the company in 1938; Phillips repaid $7,800,000 and reductions of from $1,500,000 to $2,200,000 were shown by Consolidated Oil Corp., Standard Oil Co. of Indiana and Tide Water Associated Oil Co.

Since the beginning of this year, aside from the undertaking by Ohio Oil Co., mentioned above, several other companies have arranged, or have plans, to take advantage of low money rates by refinancing existing indebtedness involving an aggregate of $115,000,000. The largest involves $60,000,000 by The Texas Corp. which will retire that amount of 3½ percent debentures due in 11 years, and replace them with an issue of a similar amount of 2¾ percent debentures due in 1965.

Standard Oil Co. (N. J.) is conducting negotiations to refinance $35,000,000 of notes which become due at the rate of $7,000,000 serially from 1943 to 1947, primarily with a view to obtaining longer maturities, while Skelly Oil Co., early this year, sold $10,000,000 of ten-year 3 percent debentures to pay off $9,000,000 of a 4 percent issue due in 1959, and borrowed an additional $6,000,000 from banks to retire its $6,300,000 of 6 percent cumulative preferred stock.

Standard Oil Co. of Ohio borrowed $4,000,000 from a New York bank to redeem, on June 1, all its outstanding ten-year debentures ($4,500,000) bearing 3½ percent interest. Tide Water Associated Oil Co. arranged a $7,000,000 bank loan to furnish funds for the construction of a Houdry catalytic unit at its Bayonne, N. J., refinery.

While net profits of the 23 companies were approximately 5 percent larger in 1939 than in the previous year, their cash dividend payments on common stock, in the aggregate, were about 6 percent smaller. Last year such payments amounted to $185,812,526 against $197,635,278 in 1938. Including Imperial Oil Co., Ltd., of Canada, and Creole Petroleum Corp. (Venezuela), both affiliates of Standard Oil Co. (N. J.), cash dividend payments of the 25 companies amounted to $219,724,960 in 1939 against $238,288,979 in the previous year.

Besides the cash payments last year, Standard of N. J. paid the equivalent of 2½ percent in common stock against only 1½ percent in 1938. Its cash payment for 1939 was equal to $1.25 a share compared with $1.50 in 1938.

Other companies which paid smaller dividends in cash on common in 1939 included Barnsdall, Imperial Oil, Shell Union, Skelly Oil, Standard of California, Tide Water and Union of California, while Ohio made no disbursement against 20 cents a share in 1938. Two companies—Standard of Ohio and Standard of Indiana—paid larger cash dividends, the former $1.50 against $1 and the latter $1.25 against $1. Pure Oil distributed the equivalent of 25 cents a share against no payment in 1938.

(Statistics for 25 representative companies will be found on the following two pages.)

FIVE YEAR FINANCIAL REVIEW

	Net Income	Per Share of Com.	Net Working Capital	Net Capital Assets	Funded and/or Long Term Debt	No. of Pref. Shares	No. of Com. Shares	Surplus
Amerada Corp.								
1939	$1,230,764	$1.56	$3,047,353	$11,801,630	.....	.....	788,675	$4,576,157
1938	1,634,486	2.07	3,680,800	11,591,429	.....	.....	788,675	4,922,742
1937	2,400,028	3.04	3,714,837	11,684,811	.....	.....	788,675	5,055,621
1936	1,983,901	2.52	4,183,364	10,684,074	.....	.....	788,675	4,232,943
1935	1,797,613	2.28	5,008,667	9,227,589	.....	.....	788,675	3,826,392
Atlantic Refining Co.								
1939	5,032,282	1.66	42,408,126	144,784,942	25,249,849	148,000	2,663,999	78,053,554
1938	4,310,913	1.40	40,723,724	142,172,139	25,406,849	148,000	2,663,999	73,270,967
1937	9,935,045	3.51	22,824,810	134,126,471	508,858	148,000	2,663,999	71,733,501
1936	7,342,197	2.59	34,627,900	113,737,073	522,793	148,000	2,664,000	64,841,504
1935	3,970,598	1.49	36,512,103	111,157,824	14,023,623	.....	2,664,901	65,617,388
Barnsdall Oil Co.								
1939	1,720,292	.76	4,334,676	11,671,041	7,575,979	.....	2,258,779	4,999,629
1938	2,837,894	1.26	2,884,341	11,416,400	5,000,000	.....	2,250,344	5,947,243
1937	1,903,029	.84	1,465,258	11,628,526	3,861,743	.....	2,250,344	6,396,684
1936	2,262,544	1.00	4,611,623	10,044,519	5,000,000	.....	2,247,974	7,471,507
1935	741,136	.34	2,152,780	7,659,141	.....	.....	2,131,090	7,256,270
Consolidated Oil Corp.								
1939	7,540,880	.55	98,179,411	196,742,476	70,481,429	.....	13,751,726	183,590,985
1938	7,737,712	.55	97,874,488	201,583,988	72,179,196	.....	13,751,846	187,049,022
1937	20,809,295	1.44	78,130,681	209,354,872	48,564,969	54,491	13,915,617	190,874,640
1936	16,728,929	1.18	78,118,866	204,171,446	49,720,570	56,592	13,944,886	182,866,672
1935	11,306,904	.74	78,377,440	200,965,255	40,181,938	106,028	13,983,237	180,540,203
Continental Oil Corp.								
1939	6,304,504	1.35	38,844,133	63,132,258	21,071,600	.....	4,682,572	71,213,345
1938	5,139,755	1.10	45,753,061	55,862,435	21,071,600	.....	4,682,581	69,591,015
1937	13,948,460	2.98	30,395,524	50,970,433	.....	.....	4,662,388	69,133,647
1936	9,612,597	2.05	28,749,999	45,374,654	.....	.....	4,738,593	61,875,373
1935	8,813,561	1.88	31,154,643	39,825,881	.....	.....	4,682,664	56,880,127
Creole Petroleum Corp.								
1939	9,590,366	1.37	7,463,866	68,869,647	.....	.....	6,974,356	42,496,303
1938	11,464,757	1.64	15,953,482	56,966,860	.....	.....	6,974,356	39,889,293
1937	11,218,752	1.61	17,073,570	52,162,879	.....	.....	6,974,356	35,638,823
1936	8,596,448	1.23	14,757,203	51,304,681	.....	.....	6,975,383	32,469,427
1935	5,509,067	.79	8,229,979	52,877,364	.....	.....	6,974,356	27,357,909
Gulf Oil Corp.								
1939	15,315,781	1.69	97,534,014	351,936,147	51,112,595	.....	9,076,202	111,929,542
1938	13,017,076	1.43	126,830,235	350,468,996	75,613,092	.....	9,076,202	115,308,601
1937	31,854,065	3.51	118,361,299	339,864,527	79,913,155	.....	9,076,202	125,071,106
1936	26,356,003	2.90	81,837,311	313,146,546	73,605,313	.....	9,076,202	102,756,263
1935	10,551,720	2.32	96,410,624	288,757,680	87,166,000	.....	4,538,101	199,049,566
Humble Oil & Refining Co.								
1939	29,950,288	3.33	40,298,938	304,322,126	42,721,438	.....	8,987,840	132,409,925
1938	35,800,354	3.98	37,440,543	295,440,883	42,640,805	.....	8,987,840	120,663,584
1937	46,924,001	5.22	8,245,084	269,905,258	1,648,181	.....	8,987,840	103,172,103
1936	34,183,527	3.80	26,962,743	226,310,687	266,945	.....	8,987,840	74,846,370
1935	23,966,326	2.66	29,002,746	204,138,789	487,610	.....	9,000,000	53,499,275
Imperial Oil, Ltd.								
1939	19,250,071	.72	43,959,297	41,125,802	.....	.....	26,965,078	49,936,345
1938	25,950,580	.96	60,013,498	40,253,368	.....	.....	26,965,078	61,202,540
1937	26,442,157	.98	64,239,390	39,808,431	.....	.....	26,965,078	73,879,023
1936	25,628,285	.95	71,088,190	43,028,222	.....	.....	26,965,078	81,133,214
1935	25,229,850	.94	72,607,155	53,572,421	.....	.....	26,965,078	89,211,979
Mid-Continent Petroleum Corp.								
1939	2,650,502	1.42	20,139,581	37,668,405	.....	.....	1,857,912	41,994,545
1938	1,043,791	.56	18,614,252	38,158,682	.....	.....	1,857,912	41,309,132
1937	5,304,877	2.85	18,404,109	39,090,197	.....	.....	1,857,912	42,231,402
1936	4,777,578	2.57	17,771,833	37,841,889	.....	.....	1,857,912	40,519,334
1935	2,417,175	1.31	17,132,369	36,662,598	.....	.....	1,857,912	38,311,091
1934	828,093	.45	15,133,343	36,947,518	.....	.....	1,843,872	36,893,649
Ohio Oil Co.								
1939	1,492,086	(A) 4.29	30,468,732	90,583,528	18,000,000	354,537	6,563,377	15,596,459
1938	4,582,964	.25	28,340,324	96,328,461	.....	354,537	6,563,377	16,231,596
1937	11,862,107	1.31	28,777,772	96,387,559	.....	548,077	6,563,577	17,710,658
1936	7,881,571	.70	32,053,658 (k)	98,929,683	.....	548,077	6,563,377	18,570,516
1935	5,488,267	.33	32,155,437 (k)	93,314,153	.....	548,077	6,563,377	17,915,323
Phillips Petroleum Co.								
1939	9,833,314	2.21	24,305,805	174,933,218	33,598,518	.....	4,449,052	38,389,001
1938	9,049,122	2.03	43,662,204	160,683,926	41,417,920	.....	4,449,052	37,453,790
1937	24,113,874	5.42	30,657,681	158,719,012	25,613,235	.....	4,449,052	37,302,764
1936	17,875,489	4.22	23,362,194	146,812,781	14,009,257	.....	4,449,052	29,153,170
1935	13,421,703	3.23	23,450,267	137,258,621	20,945,221	.....	4,152,836	21,954,036
Pure Oil Co.								
1939	8,290,418	1.11	23,186,755	112,484,522	2,361,852	721,956	3,982,031	50,781,463
1938	5,412,903	.38	19,793,782	112,992,307	2,455,668	721,429	3,982,031	47,603,610
1937	11,403,805	2.15	26,285,254	106,907,568	2,665,760	725,431	3,738,143	46,052,869
1936	7,658,372	1.63	22,195,113	115,413,650	35,194,361	359,617	3,285,120	41,385,155
1935	8,150,026	2.00	24,685,287	110,753,615	38,743,113	309,000	3,038,700	41,728,169

UNITED STATES OIL COMPANIES

	Net Income	Per Share of Com.	Net Working Capital	Net Capital Assets	Funded and/or Long Term Debt	No. of Prof. Shares	No. of Com. Shares	Surplus
Seaboard Oil Co.								
1939	$1,746,464	$1.40	$2,306,744	$3,988,415	.....	.....	1,244,383	$3,496,862
1938	1,895,790	1.52	2,368,575	2,968,905	.....	.....	1,244,383	2,994,781
1937	2,447,130	1.97	2,374,122	6,273,767	.....	.....	1,244,383	2,343,374
1936	2,485,675	2.00	1,726,067	5,750,047	.....	.....	1,244,383	3,084,451
1935	1,670,847	1.34	2,149,116	5,660,271	.....	.....	1,244,383	1,843,158
Shell Union Oil Corp.								
1939	11,805,713	.76	87,762,089	261,105,471	85,000,000	341,100	13,070,625	16,872,684
1938	11,318,423	.70	84,619,113	262,819,975	82,427,000	341,100	13,079,625	17,661,533
1937	20,668,880	1.44	54,800,185	269,950,839	61,021,430	341,100	13,070,625	17,350,251
1936	22,494,364	1.57	52,628,694	262,438,076	58,764,000	343,500	13,070,625	11,579,155
1935	6,812,835	.37	41,353,931	261,648,294	50,153,979	388,166	13,070,625	3,419,589
Skelly Oil Co.								
1939	2,360,783	1.99	7,788,739	45,009,713	9,000,000	63,000	995,348	25,581,908
1938	2,650,055	2.27	7,588,908	44,455,396	9,026,681	64,500	995,348	24,588,248
1937	6,488,346	6.06	7,823,108	40,868,979	11,734,598	66,300	1,008,549	16,297,582
1936	4,850,314	4.42	5,476,993	38,014,854	10,852,493	66,300	1,008,549	11,647,109
1935	2,585,849	2.16	5,946,672	33,260,799	8,756,859	66,300	1,000,548	9,335,556
Socony-Vacuum Oil Co., Inc.								
1938	34,452,710	1.10	189,357,083	493,139,415	126,419,256	.....	31,708,452	232,514,577
1938	40,106,917	1.29	(R) 205,882,740	(R) 458,244,042	127,511,486	.....	31,707,991	213,664,902
1937	56,808,264	1.82	223,646,989	457,125,753	128,063,217	.....	31,708,452	189,654,276
1936	42,909,362	1.38	166,291,713	424,296,564	68,372,972	.....	31,151,071	157,766,869
1935	22,525,892	.71	186,858,832	400,094,099	74,326,495	.....	31,708,456	146,736,060
Standard Oil Co. of California								
1939	17,882,505	1.36	88,095,224	446,839,002	25,000,000	.....	13,102,000	235,332,469
1938	28,875,653	2.20	64,489,533	449,350,905	.....	.....	13,102,900	236,967,035
1937	41,254,778	3.15	61,529,257	449,046,236	494,900	.....	13,102,900	229,298,177
1936	23,310,223	1.78	58,160,244	448,223,894	5,000,000	.....	13,014,754	217,070,827
1935	18,594,330	1.42	62,647,719	445,640,587	5,000,000	.....	13,102,900	212,453,308
Standard Oil Co. of Indiana								
1939	34,142,643	2.23	186,837,449	378,973,235	8,713,074	.....	15,272,014	277,716,485
1938	27,771,976	1.82	174,727,455	374,827,700	10,346,658	.....	15,272,020	280,850,326
1937	55,950,784	3.66	156,367,152	371,586,035	8,598,544	.....	15,267,030	284,891,637
1936	46,883,448	3.09	165,331,918	347,502,925	4,094,689	.....	15,196,241	265,367,464
1935	30,179,395	1.98	170,876,326	366,184,636	10,579,963	.....	15,215,677	253,904,946
Standard Oil Co. (N. J.)								
1939	89,128,756	3.26	466,607,198	1,121,061,376	190,638,179	.....	27,285,919	593,326,890
1938	76,053,170	2.86	489,684,138	1,172,251,955	192,850,838	.....	26,618,065	562,863,025
1937	147,993,147	5.64	434,929,054	1,193,534,803	139,268,806	.....	26,224,767	562,569,681
1936	97,774,583	3.73	432,337,756	1,042,421,175	84,573,564	.....	26,224,767	491,093,355
1935	62,863,192	2.43	425,337,478	1,054,520,041	82,772,730	.....	25,856,081	448,127,942
Standard Oil Co. of Ohio								
1939	5,602,499	6.64	15,403,625	43,965,974	6,702,971	120,000	753,740	23,180,208
1938	1,964,605	1.81	13,719,806	42,644,255	6,929,358	120,000	753,700	19,327,778
1937	3,362,960	3.66	10,625,869	39,874,172	.....	120,000	753,740	18,682,477
1936	4,194,314	4.76	12,764,256	34,730,917	602,026	120,000	753,740	17,112,466
1935	2,690,647	2.77	11,245,428	34,427,880	741,915	120,000	753,740	15,275,632
Sun Oil Co.								
1939	6,959,677	2.74	29,845,003	84,353,938	21,275,033	100,000	2,318,918	15,091,224
1938	3,085,119	1.07	31,085,619	79,192,720	21,386,250	100,000	2,315,960	11,182,964
1937	9,544,085	4.17	25,813,873	74,090,757	10,330,326	100,000	2,328,330	10,953,754
1936	7,563,554	3.44	20,628,939	70,007,334	6,467,583	100,000	2,156,825	10,053,004
1935	7,100,239	3.45	20,043,466	62,787,994	6,675,681	100,000	2,030,988	9,512,101
The Texas Corp.								
1939	32,886,807	3.02	136,423,045	354,847,254	102,521,409	.....	10,876,139	200,036,059
1938	23,139,030	2.13	113,780,180	339,074,007	62,869,727	.....	10,876,882	188,912,882
1937	54,574,319	5.02	127,058,606	329,648,904	65,667,412	.....	10,875,006	187,358,901
1936	38,260,341	4.10	93,179,802	295,631,713	88,819,129	.....	9,336,739	135,946,875
1935	17,065,037	1.83	125,756,164	257,074,288	93,253,676	.....	9,340,069	103,074,635
Tide Water Associated Oil Co.								
1939	8,958,971	1.05	40,018,720	126,832,660	36,848,615	500,000	6,368,667	33,094,647
1938	10,427,273	1.28	40,361,831	126,130,786	38,386,548	500,000	6,373,253	30,462,068
1937	15,801,383	2.09	42,019,706	123,923,854	39,168,798	500,000	6,369,175	28,285,935
1936	10,217,928	1.11	31,990,255	120,062,336	15,925,172	626,221	6,288,512	25,634,444
1935	7,865,701	.73	33,682,501	117,806,358	19,774,335	626,221	5,642,342	21,336,760
Union Oil Co. of California								
1939	5,846,241	1.25	48,600,877	116,536,861	38,018,500	.....	4,666,270	22,350,171
1938	6,862,758	1.47	39,408,084	115,792,578	18,018,500	.....	4,666,270	22,953,078
1937	12,061,332	2.58	41,888,136	112,174,792	18,026,500	.....	4,666,270	21,691,244
1936	6,133,398	1.40	36,147,816	107,856,361	20,326,500	.....	4,386,070	15,868,299
1935	5,038,286	1.15	35,545,741	108,543,534	21,526,500	.....	4,386,070	14,120,970

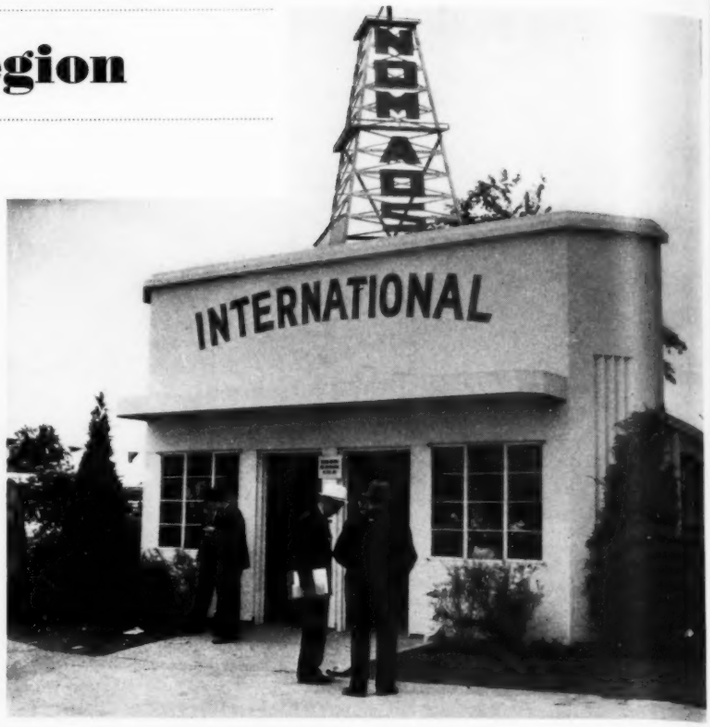
(k) Exclusive of good will, patents, etc. (A) On preferred stock.

(R) Revised because of European War and non-availability of certain figures.

Foreign Oil Legion

The International Petroleum Exposition at Tulsa which ended on May 25, attracted a great number of visitors from abroad. Many of them were accompanied by their wives and there were well over 200 foreign delegates. The Nomads club including Los Angeles, Houston, Tulsa and New York chapters were intrusted with their entertainment. The building pictured at right, located on the exposition grounds, was headquarters for foreign visitors and here several Nomads were constantly on duty to receive visitors, register them and attend to their wants.

On the 22nd Nomads gave a banquet for visitors from abroad and members of the club; over 500 attended taking advantage of the opportunity to meet their hosts and each other. In addition there were luncheons, tours and other entertainments. At the conclusion visitors expressed the opinion that it was the pleasantest and most interesting visit to the oil country they had ever enjoyed, mainly as a result of the attentions of the Nomads. On these two pages are pictured a few of the visitors from abroad.

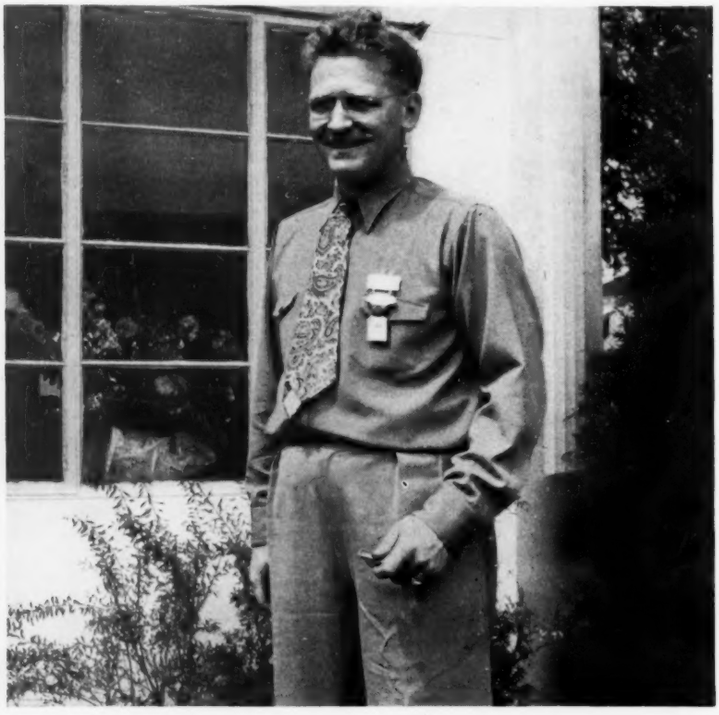


Bert Warren, purchasing agent, Standard Oil of N. J.

J. C. Clark, manager at Maracaibo of Lago Petroleum Corp.

Harold Height, manager of Standard Oil of Egypt with Dick Kester of Standard of Venezuela.

George Young, purchasing agent of Standard-Vacuum.



Maynard J. Davies, president of Davies Petroleum Co., Ltd., of Calgary, Canada.

Barton A. Myers of International Petroleum, Toronto, Canada talking to E. L. Decker, founder of the Nomads, at the banquet on Wednesday night.

G. P. Marvay, here on a scholarship of the Hungarian Ministry of Industries.

L. C. Stevens and R. A. Henkes of Caribbean Petroleum in Maracaibo.

Below, H. Cartwright Reid of Anglo-Iranian from Sussex, England.

W. M. Schaill, Mene Grande Oil Co., Maracaibo, Venezuela.

J. C. B. van den Berg, B. P. M. Netherland India.

Below, George A. Foster, formerly with Trinidad Leaseholds and W. N. Burgin of United British Oil fields of Trinidad.

A. S. Keith of Ultramar, Buenos Aires, Argentina.

Delbert Lewis of the Lucey Export Co.

WORLD OIL

All figures furnished direct to WORLD PETROLEUM by governments, except where otherwise specified. Figures in

U. S. BARRELS

	May 1939	June 1939	July 1939	Aug. 1939	Sept. 1939	Oct. 1939	Nov. 1939	Dec. 1939	Jan. 1940	Feb. 1940	March 1940	Preliminary Figures April 1940
United States	110,541,000	104,607,000	110,937,000	80,865,000	108,168,000	114,197,800	111,887,000	114,808,500	113,140,700	108,668,800	120,075,000	114,274,500
Soviet Union[4]	18,500,000	18,700,000	18,200,000	18,100,000	18,000,000	18,406,932[1]	17,813,160[1]	18,406,932[1]	18,406,932[1]	17,251,723[1]	18,454,796[1]	17,896,740
Venezuela	17,676,580	16,430,625	18,015,182	18,743,714	18,652,354	19,516,845	16,681,881	16,050,535	14,798,667	14,380,134	15,514,962	16,675,560
Iran[5]	6,801,192	6,341,652	6,637,503[1]	6,637,503[1]	6,423,390[1]	6,637,503[1]	6,423,390[1]	6,637,503[1]	6,637,503[1]	6,227,895[1]	6,745,073[1]	6,507,100
Netherland India: Sumatra	3,602,543	3,498,094	3,557,020	3,550,123	3,502,437	3,600,371	3,427,490	3,629,655	3,472,786	3,149,536	3,440,792	3,428,880
Borneo	1,173,509	1,154,341	1,156,942	1,111,810	865,693	995,207	1,068,349	1,086,713	1,093,743	1,062,210	1,097,516	1,063,890
Java[9]	530,273	514,565	565,181	559,096	511,355	556,658	549,926	633,136	561,064	507,207	562,665	537,720
Molucca[8]	89,975	77,305	73,962	71,767	68,065	64,292	62,340	60,550	59,215	62,340	54,021	67,740
Roumania	3,840,413	3,684,366	3,902,208	3,945,625	3,795,308	3,842,567	3,743,041	3,842,154	3,786,908	3,595,888	3,818,554	3,732,840
Mexico[15]	2,945,000	3,100,000	3,245,000	3,700,000	4,050,000	4,500,000	3,700,000	3,500,000	3,348,682	3,147,385	3,286,000	3,180,000
Iraq	2,663,827	2,721,992	2,807,402	2,615,129[1]	2,530,770[1]	2,615,129[1]	2,530,770[1]	2,615,129[1]	2,615,129[1]	2,461,723[1]	2,666,713[1]	2,578,020
Colombia	1,899,735	1,851,716	1,798,271	1,950,966	1,894,941	1,860,620	1,918,891	1,871,594	1,924,655	1,767,840[1]	1,895,960[1]	1,841,130
Trinidad	1,645,040	1,575,321	1,620,564	1,636,645[1]	1,583,850[1]	1,636,645[1]	1,583,850[1]	1,636,645[1]	1,636,645[1]	1,529,808[1]	1,633,421[1]	1,580,940
Argentine	1,559,568	1,533,250	1,508,738	1,495,806	1,542,755	1,632,997	1,621,927	1,691,123	1,751,910	1,797,072	1,625,981[1]	1,579,350
Peru[3]	1,078,426	1,051,265	1,100,000[1]	1,100,000[1]	1,116,810[1]	1,154,037[1]	1,116,810[1]	1,154,037[1]	1,154,037[1]	1,071,869[1]	1,139,932[1]	1,097,400
Bahrein[6]	626,009	628,812	671,892	698,714	647,595	571,673	563,985	632,962	631,644	581,255	636,577	616,410
Burma[7]	696,936	665,942	650,828	696,317	685,756	710,501	753,771	708,054	666,810[1]	629,039[1]	689,750[1]	666,810
Canada[2]	713,947	821,308	899,169	795,844	720,866	816,257	731,209	502,920	486,859	655,586	685,100[1]	719,130
Brunei[2]	486,815	464,271	490,318	488,777[1]	473,010[1]	488,777[1]	473,010[1]	488,777[1]	488,777[1]	456,576[1]	487,661[1]	471,540
Great Germany: Old Reich[14]	407,028	373,510	391,098	381,114[1]	368,820[1]	381,114[1]	368,820[1]	381,114[1]	381,114[1]	360,383[1]	386,508[1]	371,610
Ostmark[13]	64,840	74,726	85,131	58,869[1]	56,970[1]	58,869[1]	56,970[1]	58,869[1]	58,869[1]	57,072[1]	61,721[1]	61,230
Slovakia and Moravia	10,000	9,000	11,000	11,000[1]	9,810[1]	10,137[1]	9,810[1]	10,137[1]	10,137[1]	9,454[1]	10,106[1]	9,780
Poland	333,800[1]	318,000[1]	330,000[1]	330,000[1]	320,370[1]	331,049[1]	320,370[1]	331,049[1]	331,049[1]	310,155[1]	331,669[1]	320,790
Japan[10]	221,129	221,128	222,072	210,105	222,513	223,016	224,494	223,960[A]	225,308[1]	210,801[1]	224,068[1]	216,960
British India[11]	127,700	137,070	175,932	200,036	212,322	229,422	213,270	228,281	197,532[1]	180,351[1]	189,999[1]	180,090
Ecuador	193,353	193,710	206,868	204,115	193,720	193,382	196,808	205,138	204,509	188,024	211,610	208,513
Saudi Arabia	281,325	362,932	342,558	429,104	538,136	512,590	313,757	437,020	491,663	323,416	606,201	476,359
Sarawak[12]	112,572	104,224	107,961	112,716[1]	109,080[1]	112,716[1]	109,080[1]	112,716[1]	112,716[1]	104,951[1]	112,282[1]	108,330
Egypt[16]	368,081	425,231	436,519	440,678	362,880	420,519	434,174	446,846	438,367	376,043[1]	432,729[1]	454,260
Italian Empire: Albania[16]	81,839	79,931	140,025	89,000[1]	114,540[1]	118,358[1]	114,540[1]	118,358[1]	118,358[1]	112,230[1]	123,411[1]	119,250
Italy	7,253	7,181	6,843	7,600[1]	7,736[1]	7,750[1]	7,500[1]	7,750[1]	7,750[1]	7,250[1]	7,657[1]	7,380
France	42,000[1]	41,000[1]	42,000[1]	42,000[1]	42,653[1]	42,470[1]	41,160[1]	42,532[1]	42,532[1]	39,817[1]	42,439[1]	41,100
Hungary	70,000[1]	67,000[1]	70,000[1]	70,000[1]	65,210[1]	65,317[1]	65,210[1]	65,317[1]	65,317[1]	62,350[1]	67,580[1]	65,580
Bolovia	8,700[1]	8,500[1]	8,700[1]	8,700[1]	7,893[1]	8,556[1]	8,280[1]	8,556[1]	8,556[1]	7,975[1]	8,587[1]	8,310
Other Countries[17]	50,000	48,000	50,700	50,700	50,000	49,073	47,490	49,073	49,073	45,849[1]	49,786[1]	48,150
WORLD TOTAL	179,405,408	171,832,968	180,464,587	151,408,573	177,915,608	186,599,149	179,182,533	182,683,635	179,405,516	171,400,007	187,376,827	181,213,472

[A] Estimated official sources.
[1] Estimated W. P.
[2] Includes natural gasoline (naphtha) production.
[3] International Petroleum Company and Lobitos Oilfields, Ltd. figures combined.
[4] Russian Saghalin included with U.S.S.R.
[5] Anglo-Iranian Oil Company, Ltd., figures revised —fuel oil returned to the ground has been deducted.
[6] Bahrein Petroleum Company, Ltd., figures.
[7] Does not include Assam or Punjab, which are listed together under British India.
[8] British Malayan Petroleum Company, Ltd., figures.
[9] Includes Madura.
[*] Includes all other Netherland India.

Daily Averages in Barrels

	Jan.—April 1940	1939
United States	3,769,909	3,402,025
Soviet Union	595,125	588,333
Venezuela	507,184	532,965
Iran	215,848	213,430
Netherland India: Sumatra	111,504	109,910
Borneo	35,680	36,859
Java	17,922	17,904
Molucca	2,010	2,145
Roumania	123,423	127,801
Mexico	107,124	89,067
Iraq	85,302	80,758
Colombia	61,401	58,248
Trinidad	52,734	52,930
Argentine	55,820	50,228
Peru	36,886	39,303
Bahrein	20,379	21,224
Burma	21,920	19,207
Canada	21,046	15,299
Brunei	15,740	15,838
Great Germany: Old Reich	12,393	11,957
Ostmark	1,974	1,483
Slovakia and Moravia	326	320
Poland	10,691	10,695
Japan	7,249	7,370
British India	6,214	6,736
Ecuador	6,716	6,041
Saudi Arabia	15,682	6,470
Sarawak	3,622	3,718
Egypt	14,061	10,573
Italian Empire: Albania	3,911	4,476
Italy	248	264
France	1,370	1,375
Hungary	2,155	1,108
Bolivia	276	275
Other Countries	1,593	1,525
WORLD TOTAL	5,986,742	5,549,227

Official Crude Oil Production Figures for 1933 to 1939 (Revised) in Barrels

	1939	1938	1937	1936	1935	1934	1933
United States	1,264,256,000	1,214,355,000	1,279,160,000	1,098,516,060	996,596,000	908,065,000	905,656,000
Soviet Union	216,727,024	206,192,000	201,856,661	199,635,921	184,008,033	175,635,783	155,596,429
Venezuela	205,783,585	188,429,050	187,675,477	155,270,840	148,809,057	136,098,681	117,113,940
Iran	78,151,332	78,320,840	78,109,001	62,977,950	57,520,488	57,902,092	54,440,075
Netherland India: Sumatra	41,557,020	34,538,128	33,451,511	30,469,428	28,004,595	26,336,011	22,345,172
Borneo	13,125,425	12,812,383	12,960,072	13,068,910	13,529,185	14,335,543	15,003,175
Java	6,568,660	6,955,283	7,152,931	3,618,293	3,462,440	3,778,920	3,600,816
Molucca	836,144	607,622	537,436	375,823	311,872	273,698	285,335
Roumania	45,931,846	48,366,000	52,395,725	63,532,846	61,270,072	61,849,306	53,919,708
Mexico	39,428,141	38,505,824	46,455,687	41,027,915	40,240,563	38,171,946	34,000,830
Iraq	30,791,132	32,404,000	30,603,660	29,913,150	27,410,983	7,639,849	1,094,915
Colombia	22,036,613	21,581,588	20,297,543	18,756,110	17,597,655	17,337,900	13,156,126
Trinidad	19,270,256	17,736,176	15,502,989	13,237,030	11,671,224	10,894,363	9,561,353
Argentine	18,613,167	17,076,237	16,354,717	15,457,960	14,297,025	14,021,901	13,690,556
Peru	13,587,906	15,908,279	17,459,112	17,593,069	17,056,555	16,314,381	13,257,318
Bahrein	7,588,554	8,297,998	7,762,264	4,644,635	1,264,807	285,072	31,377
Burma	7,872,981	7,499,498	7,847,553	7,587,718	7,181,113	7,278,859	7,114,311
Canada	7,837,503	6,965,457	2,996,033	1,507,931	1,447,204	1,410,895	1,145,333
Brunei	5,755,164	5,387,214	4,397,038	3,296,938	3,302,905	2,705,350	2,035,656
Great Germany: Old Reich	4,487,491	3,850,044	3,148,300	3,076,858	2,967,438	2,204,402	1,656,602
Ostmark	693,247	370,038	221,266	50,092	44,347	27,965	5,765
Slovakia and Moravia	119,380	132,005	123,474	126,603	136,580	177,797	121,695
Poland	3,898,044	3,828,438	3,799,862	3,869,575	3,901,881	4,011,336	4,174,079
Japan	2,652,930	2,511,184	2,487,841	2,403,072	2,294,878	1,872,837	1,504,412
British India	2,332,467	2,330,209	2,161,653	1,978,329	2,037,810	1,921,863	1,628,803
Ecuador	2,312,118	2,257,278	2,161,436	1,942,467	1,731,785	1,636,619	1,619,902
Saudi Arabia	3,933,904	495,135	64,968	19,777	Nil	Nil	Nil
Sarawak	1,327,327	1,624,882	1,655,565	1,547,882	1,776,593	1,942,591	2,206,815
Egypt	4,602,797	1,561,231	1,163,267	1,262,666	1,255,151	1,527,252	1,653,535
Italian Empire: Albania	1,393,727	437,597	380,292	219,693	41,218	17,500	11,437
Italy	91,330	106,083	112,700	129,653	128,615	162,449	213,534
France	500,815	516,240	507,067	534,063	529,664	700,000	786,366
Hungary	769,092	330,829	13,910	100	Nil	Nil	Nil
Bolivia	100,885	106,620	123,123	104,746	163,295	157,875	111,973
Other Countries	578,036	243,000	70,000	37,100	32,300	64,000	54,100
WORLD TOTAL	2,075,512,043	1,982,639,390	2,041,170,134	1,797,791,150	1,652,023,331	1,516,760,036	1,438,797,443

PRODUCTION

Figures in U. S. barrels of 42 gal.—Conversion ratios used are weighted averages for individual countries

METRIC TONS

	May 1939	June 1939	July 1939	Aug. 1939	Sept. 1939	Oct. 1939	Nov. 1939	Dec. 1939	Jan. 1940	Feb. 1940	March 1940	Preliminary Figures April 1940
United States	14,956,000	14,153,000	15,009,700	10,941,000	14,635,096	15,450,953	15,138,276	15,533,757	15,307,901	14,702,854	16,246,164	15,461,304
Soviet Union[4]	2,536,000	2,590,000	2,500,000	2,480,000	2,300,000	2,508,024[1]	2,427,120[1]	2,508,024[1]	2,508,024[1]	2,360,194[1]	2,531,522[1]	2,436,780
Venezuela	2,624,585	2,439,598	2,674,860	2,783,031	2,769,466	2,897,824	2,476,894	2,383,153	2,197,278	2,135,135	2,303,632	2,475,930
Iran[5]	902,208	841,248	880,493[1]	880,493[1]	852,090[1]	880,493[1]	852,090[1]	880,493[1]	880,493[1]	826,152[1]	894,753[1]	863,190
Netherland India: Sumatra	461,214	447,842	455,386	454,503	448,398	460,936	438,803	464,685	444,602	403,218	440,506	438,960
Borneo	150,238	147,784	148,117	142,339	110,830	127,411	136,775	139,126	140,026	135,989	140,509	136,290
Java[5]	67,888	65,877	72,357	71,578	65,466	71,266	70,404	81,057	71,830	64,935	72,035	68,820
Molucca*	11,519	9,897	9,469	9,188	8,842	8,231	7,981	7,752	7,581	7,981	6,916	8,670
Roumania	520,734	499,575	529,113	535,000	514,618	521,026	507,531	520,970	513,479	487,578	517,770	506,130
Mexico[13]	432,452	455,212	476,505	543,316	594,713	660,973	543,318	513,950	492,094	462,171	482,525	466,960
Iraq	356,079	363,854	375,271	349,556[1]	338,280[1]	349,556[1]	338,280[1]	349,556[1]	349,556[1]	330,034[1]	356,531[1]	344,670
Colombia	264,956	258,258	247,017	272,101	264,287	257,920	267,627	260,524	268,431	246,094[1]	263,872[1]	256,200
Trinidad	231,370	221,564	227,927	230,206[1]	222,780[1]	230,206[1]	222,780[1]	230,206[1]	230,206[1]	215,151[1]	229,710[1]	222,360
Argentine	222,160	218,411	214,919	213,077	219,765	232,620	231,043	240,900	249,559	255,993	231,601[1]	224,970
Peru[3]	142,367	138,782	146,000[1]	146,000[1]	147,810[1]	152,737[1]	147,810[1]	152,737[1]	152,737[1]	141,810[1]	150,784[1]	145,200
Bahrein[2]	85,353	85,665	91,551	95,348	87,030	78,012	76,963	86,375	86,195	79,319	87,017	83,970
Burma[1]	96,261	91,980	89,893	96,176	94,717	98,135[1]	104,112	97,797	92,101[1]	86,855[1]	94,147[1]	91,980
Canada[3]	90,856	104,518	114,427	101,278	91,736	103,875	93,052	64,001	61,957	83,429	87,172[1]	87,480
Brunei[3]	64,943	61,935	65,410	65,193[1]	63,090[1]	65,193[1]	63,090[1]	65,193[1]	65,193[1]	60,900[1]	65,038[1]	62,880
Great Germany: Old Reich[14]	58,205	53,412	55,927	58,300[1]	53,190[1]	54,963[1]	53,190[1]	54,963[1]	54,963[1]	51,997[1]	55,800[1]	53,940
Ostmark[15]	9,666	11,289	12,691	13,000[1]	9,030[1]	9,331[1]	9,030[1]	9,331[1]	9,331[1]	9,048[1]	9,827[1]	9,780
Slovakia and Moravia	1,500	1,400	1,600	1,600[1]	1,550[1]	1,519[1]	1,470[1]	1,519[1]	1,519[1]	1,421[1]	1,519[1]	1,470
Poland	45,000[1]	41,000[1]	45,000[1]	45,000[1]	42,960[1]	44,392[1]	42,960[1]	44,392[1]	44,392[1]	41,644[1]	44,516[1]	43,050
Japan[9]	31,455	31,454	31,544	31,721	31,651	31,723	31,933	31,857[A]	32,178[1]	30,131[1]	32,023[1]	31,020
British India[11]	17,638	18,932	24,300	27,629	29,326	31,688	29,457	31,530	27,280[1]	24,911[1]	26,226[1]	24,870
Ecuador	25,491	25,539	27,272	26,910	25,540	25,495	25,947	27,045	26,962	24,788	27,898	27,490
Saudi Arabia	38,110	41,037	46,404	58,129	72,899	72,899	42,503	59,201	66,604	43,812	82,120	64,531
Sarawak[12]	14,386	13,329	13,797	14,539[1]	14,070[1]	14,539[1]	14,070[1]	14,539[1]	14,539[1]	13,543[1]	14,415[1]	13,920
Egypt[13]	52,568	60,730	62,342	62,936	51,810	60,057	62,150	63,817	62,606	53,534[1]	58,125[1]	57,150
Italian Empire: Albania[16]	12,266	11,980	20,987	13,000[1]	17,100[1]	17,670[1]	17,100[1]	17,670[1]	17,670[1]	16,762[1]	18,415[1]	17,790
Italy	901	892	850	950[1]	961[1]	961[1]	930[1]	961[1]	961[1]	899[1]	930[1]	900
France	6,000[1]	5,700[1]	6,000[1]	6,000[1]	5,760[1]	5,952[1]	5,760[1]	5,952[1]	5,952[1]	5,568[1]	5,952[1]	5,760
Hungary	9,500[1]	9,000[1]	9,500[1]	9,500[1]	8,490[1]	8,773[1]	8,490[1]	8,773[1]	8,773[1]	8,381[1]	9,052[1]	8,760
Bolivia	1,000[1]	1,000[1]	1,000[1]	1,000[1]	960[1]	992[1]	960[1]	992[1]	992[1]	928[1]	992[1]	960
Other Countries[17]	7,000	6,700	7,100	7,100	7,000	6,975	6,750	6,975	6,975	6,525	7,006	6,780
WORLD TOTAL	24,547,815	23,528,394	24,694,749	20,786,697	24,201,311	25,543,320	24,496,649	24,959,773	24,500,940	23,419,684	25,597,020	24,750,825

[1] Japanese Saghalin, Taiwan (Formosa) and Hokkaido included with Japan.
[2] Excluding Burma.
[3] Sarawak Oilfields, Ltd., figures.
[A] Estimated Official Sources
[5] Anglo-Egyptian Oilfields, Ltd., figures.
[6] Prussia, Thuringia and Baden.
[7] Formerly known as Austria.
[8] Italian imports of Albanian crude oil.
* Includes all other Netherland India.
[17] Estimate representing Morocco, Cuba, New Zealand, Barbados, Greece, Algeria, Yugoslavia, Australia, Great Britain, Kuwait and China.
[18] Official Figures—Petroleos Mexicanos.

Daily Averages in Metric Tons

	Jan.—April 1940	Jan.—April 1939
United States	510,067	460,292
Soviet Union	81,293	86,970
Venezuela	75,305	79,035
Iran	28,632	28,312
Netherland India: Sumatra	14,275	14,071
Borneo	4,567	4,776
Java	2,294	2,292
Molucca	257	277
Roumania	16,735	17,329
Mexico	15,733	13,114
Iraq	11,411	10,792
Colombia	8,550	8,123
Trinidad	7,416	7,445
Argentine	7,951	7,146
Peru	4,880	5,202
Bahrein	2,781	2,893
Burma	3,017	2,652
Canada	2,644	1,113
Brunei	2,107	2,114
Great Germany: Old Reich	1,790	1,709
Ostmark	313	221
Slovakia and Moravia	49	49
Poland	1,434	1,434
Japan	1,035	1,048
British India	851	930
Ecuador	885	813
Saudi Arabia	2,124	877
Sarawak	466	483
Egypt	1,912	1,509
Italian Empire: Albania	583	670
Italy	30	33
France	192	192
Hungary	288	261
Bolivia	32	33
Other Countries	225	222
WORLD TOTAL	812,136	759,033

Official Crude Oil Production Figures for 1933 to 1939 (Revised) in Metric Tons

	1939	1938	1937	1936	1935	1934	1933
United States	171,053,443	164,346,325	172,822,797	148,707,864	134,912,143	122,913,903	122,601,191
Soviet Union	29,530,168	28,859,000	27,867,025‡	27,384,900	25,241,100	24,092,700	21,330,100
Venezuela	30,533,706	27,845,286	27,733,926	22,945,299	21,990,373	20,112,115	17,293,193
Iran	10,367,112	10,358,495	10,330,480	8,329,289	7,607,500	7,657,970	7,200,093
Netherland India: Sumatra	5,320,320	4,662,836	4,490,137	4,114,710	3,759,006	3,535,035	2,999,352
Borneo	1,680,377	1,719,783	1,739,607	1,773,545	1,815,998	1,924,234	2,013,849
Java	840,950	933,595	960,125	499,097	464,757	510 320	483,331
Molucca	107,047	81,560	72,139	50,446	41,862	36 738	38,300
Roumania	6,228,047	6,603,000	7,153,000	8,704,000	8,394,000	8,473,355	7,387,000
Mexico	5,794,215	5,716,423	6,896,657	6,090,842	5,973,955	5,666,857	5,049,109
Iraq	4,115,845	4,345,000	4,126,185	4,079,066	3,724,231	1,048,108	147,943
Colombia	3,067,568	3,007,935	2,844,251	2,614,092	2,452,635	2,416,432	1,833,606
Trinidad	2,710,515	2,472,943	2,181,676	1,862,796	1,642,446	1,533,122	1,345,532
Argentina	2,651,448	2,432,857	2,330,063	2,202,304	2,036,903	1,997,706	1,950,499
Peru	1,798,557	9,099,885	2,313,691	2,331,454	2,260,903	2,161,990	1,756,867
Bahrein	1,033,472	1,130,734	1,058,557	635,555	173,072	39,008	4,293
Burma	1,087,424	1,039,960	1,083,391	1,047,593	991,456	1,004,951	982,233
Canada	997,391	879,921	378,478	190,495	182,820	178,233	144,686
Brunei	767,700	707,123	576,545	470,991	471,842	386,478	290,808
Great Germany: Old Reich	647,337	552,074	453,451	444,600	427,400	317,500	238,600
Ostmark	109,904	63,468	33,010	7,473	6,616	4,172	860
Slovakia and Moravia	18,103	19,282	18,036	18,665	19,946	25,971	17,776
Poland	522,874	504,678	501,301	510,630	614,760	529,200	550,670
Japan	379,161	356,328	341,040	341,976	326,580	266,520	212,667
British India	322,160	322,125	298,450	273,137	281,072	265,341	224,879
Ecuador	306,824	319,877	306,326	275,293	245,434	231,947	229,578
Saudi Arabia	536,366	66,683	8,070	2,447	Nil	Nil	Nil
Sarawak	171,322	200,126	217,085	221,126	253,799	277,513	315,259
Egypt	657,510	223,058	166,298	177,491	176,436	214,671	232,437
Italian Empire: Albania	208,279	65,313	56,760	32,760	6,152	2,500	1,707
Italy	11,346	13,178	14,000	16,106	15,977	20,180	26,526
France	70,224	72,106	71,008	74,788	74,172	98,025	110,120
Hungary	103,364	42,798	13,910	13	Nil	Nil	Nil
Bolivia	11,904	13,262	15,487	13,197	20,540	19,858	14,085
Other Countries	82,300	34,080	10,000	5,300	4,600	9,100	7,700
WORLD TOTAL	283,844,283	279,111,097	279,482,962	246,449,340	226,610,486	207,971,753	197,034,849

One million dollar cheque as the first installment of a total payment of $8,500,000, being handed by Ambassador Francisco Castillo Maera of Mexico to M. L. Gosney, treasurer of Consolidated. Patrick J. Hurley, representing Sinclair interests in the Mexican negotiations, is in the center.

© International News

Mexico Buys Sinclair Properties

EARLY in May it was announced by Mexican officials that an agreement had been reached for settlement of the claim of the Consolidated Oil Company arising out of the seizure of its properties by the Mexican government on March 18, 1938. This report was confirmed by H. F. Sinclair, chairman of the Consolidated, in his annual report to stockholders on May 15.

Actually the claims covered by this agreement were those of four subsidiary companies of Consolidated, namely, Mexican Sinclair Petroleum Co., Sinclair-Pierce Oil Company, Stanford & Co., and Compania Terminal de Lobos, S. A. In payment for the property of these companies and of all claims arising from expropriation the government of Mexico agreed to pay the sum of $8,500,000. The first installment of $1,000,000 was handed over to representatives of the Consolidated by the Mexican ambassador in Washington on May 18 as pictured above. A second $1,000,000 payment is due in August and a third in November. Subsequent payments are to be made at intervals of four months until the full amount of $8,500,000 has been liquidated.

Directly following the conclusion of the above agreement a contract was signed by representatives of Consolidated with Distribuidora de Petroleos Mexicanos, sales organization of the Mexican oil administration, for the purchase of 5,000,000 bbl. of crude oil yearly for the ensuing four years. Presumably because the two transactions took place so close together reports have been published that both were parts of the same agreement. This is denied emphatically both by the oil company and by Mexican officials. Moreover, it is emphasized that Mexico guarantees that all oil delivered under the contract is to come from lands owned by the government and not from expropriated fields.

The price to be paid for the purchased oil is understood to be based on Gulf quotations for crude of similar quality. Deliveries under the contract have commenced and the first cargo arrived at Marcus Hook on May 23.

While the agreement referred to covers the properties of wholly owned subsidiaries of Consolidated in Mexico two other companies in which Consolidated holds a controlling interest were not included. These companies are Penn-Mex Fuel and "El Charro". Legal difficulties involved in getting the assent of minority shareholders are given as the reason for excluding the properties of these two companies in the settlement.

Roumanian police boat on the Danube assuring uninterrupted oil shipments.

© British Combine

While no information has been given out as to the valuation placed by the oil company on the properties included in the recent agreement it is understood that the amount of the payment was substantially below their real value but approximately equal to the figure at which they were carried on the books of the company.

New Production In France

WHILE mobilization in September 1939 temporarily delayed progress in the search for oil which was being conducted in the department of Haut Garonne, southern France, by the national administration of liquid fuels, the war has not been permitted to interrupt this exploratory work. A press report on May 26 stated that these efforts had been rewarded by the bringing in of a flowing well from a depth of around 8,000 ft. The rate of flow is not given in this report except for the statement that it is "unexpectedly satisfactory" and under great pressure.

As reported in WORLD PETROLEUM last September a well drilled at St. Marcet, near Toulouse, in the region of the Pyrenees developed a showing of 6,500,000 cu. ft. of wet gas at a depth of 4,972 ft. The conclusion reached at the time was that this well was on the top of the anticline and arrangements were made to put down a second bore to lower depths on the same structure. This second well was named the Louis Pineau in honor of the head of the Bureau de Combustibles Liquides and presumably is the one referred to in the recent dispatch. The oil obtained from the new well is reported to be of 0.86 gravity and to contain over 20 percent of gasoline and a high percentage of lubricating oil components.

WAR DEMAND

(Continued from page 23)

continuance of operations on anything like their present scale will require even larger quantities of petroleum products than were calculated as necessary before the opening of the struggle. At that time it was computed that Germany's needs would be upward of 15,000,000 tons a year while those of the Allies would be something more than double this amount. That the rate of consumption now in effect is making considerable draughts on the stocks accumulated before the commencement of the war is obvious. Within the past fortnight representatives of the allies have been seeking to purchase cargoes in the United States in addition to their previously established sources of supply. Thus far at least, Germany has been using motor fuel and lubricants on a larger scale than her opponents in an effort to win victory in a short, sharp conflict. Unless this expectation is realized the question of maintaining adequate supplies for her vast military operations seems certain to become a very serious problem.

WORLD PETROLEUM ABSTRACTS

Summaries of the Most Important Articles as Published in the Oil Press of the World Dealing With Technical and Economic Aspects of the Petroleum Industry. Edited by Dr. O. W. Willcox

GEOLOGY

Use of the Schmidt Magnetometer in the Search for Oil Deposits—Gerhard Neumann, in OEL UND KOHLE, Vol. 36 (1940) No. 9, pp. 75-78.

The author reviews the accomplishments of the Schmidt magnetometer in the field of oil prospecting. Elaborate studies on the salt domes of northern Germany, as well as experience in the Gulf Coast region of the United States, have shown that the magnetometer has little claim as an independent means of geophysical exploration in the clastic formations of such regions. The most that can be said is that the faint anomalies observed in these regions are of interest as corroborative of the results of other methods.

The case is different, however, when masses of heavy crystalline rocks occur in association with sedimentary deposits whether as intrusive masses that cause arches, or as basin walls within which lighter sediments have been deposited. The latter is the case with some German regions where oil is found in weakly magnetic strata flanked by zones of greater magnetic potency. The magnetometer is thus well suited for reconnaisance surveys, to be followed by detailed seismic and gravimetric surveys. Magnetic instruments have rendered especially good service in the Southwestern United States for detecting crystallizine rocks that have been responsible for structure. An example is the Hobbs field (N. M.), where magnetic anomalies of several hundreds of gammas have been observed. Structurally high-lying paleozoic beds have also been magnetically defined in the Texas Panhandle, where oil-bearing beds flank a buried granite mountain range.

Magnetic observations have also been useful in locating buried laccoliths of basic volcanics that have intruded into sedimentary strata. Due to the strong magnetism of basalt and other basic eruptive rocks they readily show their presence, as in the East Carroll and Ridgeland fields (La.). The same applies to the products of the weathering of these young volcanic rocks, which produced porous beds for the accumulation of oil in the Balcones region of Texas, especially in the Austin District. Oil traps formed by intruded basaltic dykes have been successfully delimited in Mexico, and also faults in which crystalline rocks have been involved.

Relation of Temperature to Structure in the Salt Creek Field, Wyoming—C. E. Van Orstrand, in GEOPHYSICS, Vol. 5 (1940), No. 1, pp. 47-56.

Observations of bottom hole temperatures in approximately 100 deep wells in the Salt Creek field have been made during the past few years by the Stanolind Oil and Gas Company. These recent observations confirm and extend in a remarkable manner the results obtained in the summers of 1922 and 1923, when it was found from temperature surveys in 21 wells that the temperatures over a considerable portion of the field were definitely related to the structure.

It appears that the most important factors at Salt Creek are differences in thermal conductivity parallel to and transverse to the laminations of the strata, and recent uplift and erosion which have brought the hot rocks close to the surface of the ground.

Barium in Appalachian Salt Brines—E. T. Heck, in BULLETIN AMERICAN ASSOCIATION PETROLEUM GEOLOGISTS, Vol. 24 (1940), No. 1, pp. 486-493.

Many Appalachian brines contain appreciable amounts of barium, a fact that has not been generally known until recent years. Barium has been found in brines from rocks of Silurian, Devonian, Mississippian, and Pennsylvanian age. Apparently the barium was originally present in the sediments as barite and progressive destruction of the sulphate radicle brought the metal into solution. It has been shown that the areas most productive of oil and gas also produce the brines that contain the largest percentages of barium. Meteoric water entering at the outcrop has apparently precipitated barium from the brines in some parts of West Virginia.

DRILLING

Squeeze Jobs Against Gas in Amelia Oilfield, Jefferson County, Texas—Ed. J. Hainner, in BULLETIN AMERICAN ASSOCIATION PETROLEUM GEOLOGISTS, Vol. 23 (1939) No. 11, pp. 1635-1665.

This field is an interesting one, not only for its peculiar geological features, but also for the presence of unusually difficult completion and production problems. A new method of completing low gas-oil ratio wells was developed at Amelia and has since been used extensively in other fields of the Gulf Coast.

The greatest completion difficulty encountered was in shutting off the free gas. In spite of the fact that casing was set below the point where free gas should not be produced, the gas followed channels in the cement behind the casing, between the cement and the walls of the hole, or through any opening available, and was produced with the oil, thus making a high-ratio well out of a well which should have been a normal low-ratio producer. Naturally this excess production of free gas held back the oil and did not allow as much to be produced as the wells were capable of yielding.

The ordinary liner method proved inadequate and the operation was performed as follows: The offending well was killed and the setting pulled; a cement retainer was set close to the bottom of the casing; a 4-foot zone gun was perforated with 6-12 holes in the casing just below the gas-oil contact, the top of the zone usually 1–3 feet below the contact; a second cement retainer was set immediately above the perforated zone; and 75 sacks of cement were squeezed through the perforations into whatever voids existed behind the casing. The squeeze pressure was applied with high-pressure pumps and for different jobs varied from 2,500 to 4,000 pounds per square inch of surface pressure. The amount of cement actually squeezed behind the casing varied according to the condition of the hole and the old original cement job.

The method has worked so satisfactorily and successfully that it is used on all doubtful wells before original well completion.

Rotation of Casing While Cementing—B. Mills, in OIL WEEKLY, Vol. 95 (1939), No. 13, pp. 14-15.

In the cementing of oil strings an important object is to secure even distribution of the cement around the casing, without any channelling or sticking during the cementing operation. In the past this has been more or less successfully accomplished by giving the casing an up and down motion while the cement is running in.

This practice has been changed by the Quintana Oil Company in the Tom-Oconnor field (South Texas) into giving the casing a rotatory motion. This idea presupposes that the hole is a straight one; that the casing is threaded and coupled so that it will stand rotating, and that the casing is free in the hole before rotating starts. These conditions being fulfilled, the 5-inch casing string is clamped to the rotary table and rotated at 25 to 30 r.p.m. for an hour, or during the period occupied by mud conditioning, cement mixing and pumping down, and is stopped about when the cement plug reaches bottom. Power required to rotate the casing is negligible and the results of cementing about 175 wells by this method have been satisfactory.

Complex Phosphates for Deflocculation of Drilling Mud—C. F. Bonnet, in OIL & GAS JOURNAL, Vol. 38 (1940), No. 33, pp. 39; 42.

Among agents for conditioning drilling muds, certain complex phosphates have claims for consideration. Among these are tetrasodium pyrophosphate and sodium tetraphosphate, which are produced by partial dehydration of normal phosphate hydrates. Both the above named complex phosphates are found to have sharply defloccuating effects on fresh muds. Perhaps the best of the two is the sodium tetraphosphate, which is fairly stable in solution, promotes settling of sand, and high concentrations have little tendency to increase viscosity. The practical possibilities of these new mud-treating chemicals have not yet been fully tested, but they are very likely to prove of considerable interest to mud engineers.

Simultaneous and Continuous Electric Logging and Drilling—B. Mills, in OIL WEEKLY, Vol. 96 (1940), No. 4, pp. 16-20.

Electric logging of a drilled oil well has heretofore been done by lowering special electrodes and wire connections into the uncased hole and in the absence of the drill pipe, which required discontinuing the drilling operations while the formations were being logged.

A recent development is to make electric

logging simultaneous and continuous. This is effected by running an insulated wire down the drill pipe to the bit at the bottom of the hole; the bit is thus made the electrode for logging purposes, and as such is electrically insulated from the drill pipe. At the surface a swivel connection is provided so that the presence of the conducting wires will not interfere with the rotation of the bit. Also, arrangements are made for lengthening the wire as the hole is deepened and new joints of drill pipe are added. The result is that the earth's electrical resistance and the earth potential are continually recorded by meters at the surface. The presence of the wire cable offers little inconvenience to the drilling crew in going in or coming out of the hole.

This device has been used on six wells of the Amerada Petroleum Corporation in Texas. The results are said to be encouraging.

The Carter Pressure Core Barrel—Ben W. Sewell, before AMERICAN PETROLEUM INSTITUTE, Chicago, November, 1939.

A pressure core barrel is a coring device which differs from conventional core barrels in that the core, after having been cut, is sealed within a chamber and brought to the surface under pressure.

The primary purpose of such a core barrel is to prevent the loss of the contents of the core due to expansion as the pressure surrounding the core is reduced, thus permitting a more accurate determination of its original content.

Briefly, the Carter pressure core barrel may be described as a convential core barrel containing a third tube between the inner and outer barrels. This third tube is provided with valves at both ends, and an arrangement for lifting the inner barrel containing the core up into it—after which the valves are closed.

The particular functions of a pressure core barrel are listed as follows:

A more certain determination of reservoir content than is furnished by the conventional non-pressure-type core barrel.

Location of gas caps and determination of content.

Studies of oil, gas, and water gradients through a producing zone.

Studies in well spacing.

Studies of oil remaining in place in depleted fields by drilling and coring intermediate wells.

Studies of various methods and rates of production by working on cores while cores are under pressure.

Studies of contamination of cores.

Mechanical Practicability of Electric Logging While Drilling—David G. Hawthorne and John C. Owen in PETROLEUM ENGINEER, Vol. 11 (1940) No. 4, pp. 71-74; 76-78.

One of the great needs of rotary drilling practice has been a means of obtaining immediate information on the nature and characteristics of the formations that are being penetrated by the bit. Lacking such means, potential oil-and gas-producing horizons may be drilled through and passed by without detection, and many of these horizons are not discovered then or later. The only safeguard against such oversights has been conventional coring operations, which are expensive.

Ordinary electric logging is an approach to a solution, but lacks the convenience of and immediate availabliity of the new method of continuous electrical logging during the drilling operation itself.

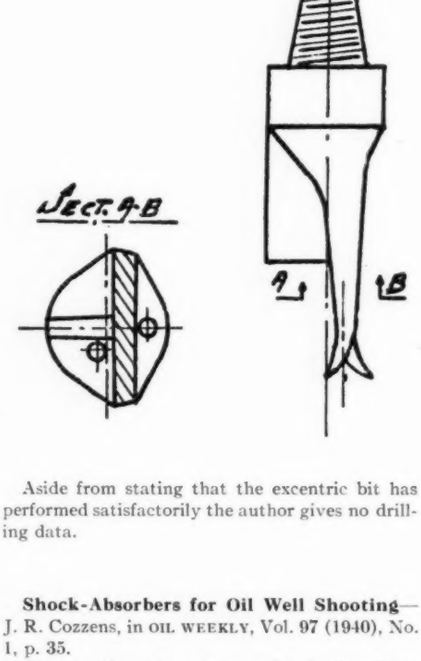
The new system, which has already attracted considerable attention, is minutely described. It consists simply in making the drilling bit the electrode of an electric logging circuit. This requires special means for providing an insulated cable along with the drill pipe.

Considerable difficulty was encountered at first, but as experience was gained the sources of trouble were identified and removed. As the matter now stands the outfit functions smoothly and affects drilling time in an almost negligible degree.

The special advantages of the system are most evident in the drilling of wildcat wells, and also in the drilling of proven structures that are difficult to explore.

Excentric Rock Bits in Rotary Drilling—N. Parvulescu, in ANNALES MINES ROUMANIE, Vol. 22 (1939), No. 12, pp. 519-521.

The "Steaua Romana" is using an excentric rock bit in the Tzintea field in Roumania. The accompanying illustration conveys the idea. The excentricity is e-.008d (d being the diameter of the bit), which allows the making of a hole about 15 percent wider than the bit diameter. Thus, with a 195 millimeter bit having an excentricity of 15 millimeters, there is obtained a hole 218 millimeters in diameter.



Aside from stating that the excentric bit has performed satisfactorily the author gives no drilling data.

Shock-Absorbers for Oil Well Shooting—J. R. Cozzens, in OIL WEEKLY, Vol. 97 (1940), No. 1, p. 35.

The shooting of newly completed oil wells to start or increase the flow of oil is a settled practice of petroleum technology. In most cases the shot has the desired effect, but in other cases and in certain fields, as in Southern Ohio, it leads to the opposite result. In such cases the initial flow diminishes and may even disappear entirely. This loss of flow following the shooting of the well is mostly due to the effect of the explosion in cracking the underlying shales, in which fissures are created that allow the oil to escape into lower formations.

To prevent this unwelcome occurrence in cases where it is to be feared, it is found to be good practice to drill a pocket into the oil sand somewhat deeper than is usually the case; that is, the extra pocket starts at the exact point in the sand body where the lower tip of the explosive charge is to rest, and is continued down for three to six feet, depending on the amount of sand-face to be blasted. The extension of the pocket is filled and tamped with short asbestos fiber or rock-wool insulating material. The explosive in its container is then lowered to rest on the tamped fiber and fired in the usual manner.

The purpose of the fiber is to cushion the downward thrust of the explosion and thus avoid shattering the underlying shale or other leak-proof bottom. Application of the method has greatly reduced the proportion of wells that fail to "come back" after shooting.

Well Logging by Radioactivity—G. H. Westby and S. A. Scherbatskoy in OIL & GAS JOURNAL, Vol. 38 (1940), No. 41, pp. 62-64.

Attention is directed to the fact that rocks composing the earth's geologic crust differ in radioactivity. The property of radioactivity of rocks is due to the presence in them of radioactive elements, of which about 42 are known. The most active of these is the element radium. This element is widely disseminated in the primary or oldest rocks, such as primary granite and syenite. When these primary rocks are decomposed by geochemical processes and converted by erosion and sedimentation into stratified formations, the radium and other radioactive substances are incorporated in the various beds and strata.

The interesting fact is that the different kinds of strata contain different amounts of radium and related substances. Shales are usually the most highly radioactive of the sedimentary formations. Sandstones, which are composed almost entirely of pure quartz, and the pure limestones, are the least radioactive. Between these two extremes there may be mixed or impure deposits, clays, marls, etc., which have a radioactivity that depends on the amount of radioactive detritus that has entered into their composition. The upshot is that every bed has a definite radioactive index.

On this is based the new method of making a radioactive survey of oil wells. An apparatus that carries an electrometer which is sensitive to radioactive emanations (gamma rays) is lowered into the well and a record is obtained of the gamma ray reactions of the beds that are passed. As this is a convenient method of distinguishing sands from shales the utility of the method is obvious. In contrast to an electrical conductivity survey the presence of the well casing does not affect the record. This makes it possible to survey old wells of which no accurate log was taken when drilling. Present experience shows that the new method gives results that agree closely with electrical logging.

OPERATION

Gas Injection at Loudon, Illinois—R. J. Sullivan, in PETROLEUM TECHNOLOGY, Vol. 3 (1940), No. 1 Technical Publication No. 1173; 15 pages.

The gas-injection program of The Carter Oil Company in this field is considered to be unprecedented, and a new departure in operations of this type.

Essentially, the project is one of high pressure or early-life repressuring as contrasted with pressure maintenance or low-pressure gas injection. Loudon leases are usually small, and their size, coupled with the strong competitive situation, rules pressure maintenance out of consider-

ation because of the infeasibility of gas-cap control and fair treatment of all royalty owners. Repressuring, or the familiar gas-drive type of injection, is applied usually to a relatively depleted property as a secondary or delayed method of recovery. It amounts to reclaiming by mechanical propulsion oil retained in the pore openings of the formation; that is, to supplying a differential pressure, even of small magnitude, tending to promote movement of practically gas-free crude toward producing wells. It has thus been in the past a low-pressure, low-volume kind of operation, involving considerable recycling. But experience has led to the conclusion that the degree of improvement in recovery by repressuring, all other factors standing equal, is inversely governed by the stage of depletion at which gas injection is begun. In other words, the percentage of additional yield from a property wholly depleted by normal methods is not as great as that of a property only partly depleted.

Objectives of the Loudon program, then, are to supplement natural energy so as to drive underground oil while it remains in its most fluid state, to avoid at the same time the drilling of unnecessary and even harmful wells, and to conserve and process a meager gas supply before it has been dissipated.

During the first nine months of operation there was very little average reservoir change, gas reproductivity excepted. The response is regarded as most encouraging, since general gas-drive action has been definitely established.

Recent Changes in California Voluntary Oil-Curtailment Methods—Joseph Jensen, in PETROLEUM TECHNOLOGY, Vol. 3 (1939), No. 1, Technical Publication No. 1153; 13 pages.

The new formula recently inaugurated in California establishes the allotment for all wells by giving consideration to but three items, namely:

1. A graduated minimum allotment based on the depth of the well,

2. A remaining allotment derived by applying a power factor to the remaining potential of the well, said remaining potential being the difference between a well's potential and its minimum allotment,

3. A top allotment for the larger wells that varies according to the demand for oil or the outlet for the oil that is produced.

Minimum allotment—One barrel per day per 200 ft. of depth to 1000 ft.; adding cumulatively one barrel for each 1000 ft. of additional depth, but no well to receive less than 10 bbl. per day if capable of that production.

The whole system is shown on a sheet from which any operator can figure his own allotment.

Formerly, to secure oil for new wells, it was necessary to take some allotment from all fields. This was called potential or production decline, but as an actual matter of fact it was an arbitrary deduction from all fields. The result was that the small wells in old fields were cut so heavily that vigorous complaint was registered by their owners. It was evident that these wells would soon have to stop operating because, if the method continued, the wells would operate at a loss. Under the new formula the operator's allotment changes with his own potential, except for the very insignificant change made in the power factor when that is necessary. Thus an operator having no top wells and doing no drilling is no longer affected by the completion of new wells, either in his own field or in other fields. The only change in his allotment (unless his wells are top wells) is that absolutely related to the change in potential of his own wells. Therefore he can reasonable expect that there will be only a gradual change in his allotment.

The new formula is said to have received excellent support from the whole industry, which is considered convincing evidence of its fairness and impartiality.

Disposal of Salt Water in the East Texas Field—A. S. Rhea and E. B. Miller, Jr., in PETROLEUM TECHNOLOGY, Vol. 3 (1940), No. 1. Technical Publication No. 1151; 10 pages.

The problem of disposal of salt water in the East Texas Field has been brought to a practical solution by injecting it into the Woodbine sand some distance beyond the western edge of production. Experience gained with this test project, which is a cooperative undertaking by 15 operators, is regarded as warranting general adoption in the field.

Two systems were tried. One was a closed system in which the salt water is excluded from contact with air and returned to the sand in nearly the same condition as when removed. However, the sand face became seriously plugged with precipitated iron oxide and sulfide. This system was then abandoned in favor of an open system in which the water was exposed to air as much as possible to promote oxidation of precipitable substances, which were removed by filtration before injection into the sand, and this system has been found to be satisfactory.

The oxidized and filtered salt water is very corrosive and has to be prevented from coming into contact with unprotected iron or steel. Cement-lined pipe is used to case the injection well. Great care is said to be necessary in completing and cleaning out the disposal well, so that all foreign material may be removed from the sand face.

The cost of a well and plant for disposal of salt water varies from $20,000 to $30,000. The cost per barrel for disposal of salt water is still an unknown quantity, since the plants have not been in operation long enough to determine the life expectancy of a disposal well.

Recent Secondary Recovery of Oil in Ohio—E. V. O'Rourke, in BULLETIN AMERICAN ASSOCIATION PETROLEUM GEOLOGISTS, Vol. 24 (1940), No. 1, pp. 492-493.

Since secondary recovery of oil by water flooding has been made legal in Ohio a flooding project has been started on a 10-acre farm near Chatham, Medina County, where old production came from the Berea sandstone. On this property has been drilled thirteen new holes, nine of which were water wells with a space of 330 feet and four wells to be used in production. The depth to the top of the producing sand there is about 350 ft. and the average sand thickness exposed in the thirteen new holes was approximately 150 ft. Water is secured in alluvial material and is pumped in a closed system from a place about three-quarters of a mile northeast of the input wells. The deep well pump has lifted as much as 3,000 barrels per day to be used for water injection. The accumulative water input per well varies greatly but so did the original oil production and sand thickness. Thus far, there has been an increase of 2,200 percent in oil production from the farm and only about one-eighth of the farm is being flooded. The gravity of the oil has increased since the work started.

The amount of oil produced from the variety of formations in southeastern and central Ohio above the Clinton sand is probably 185 million barrels. All the territory that has produced this oil is good for economic water flooding at various oil prices. The formations or the main producing horizons are as follows: Cow run, Macksburg, Keener, Big Injun, Berea.

REFINING

Improved Calculation Methods of Absorber Performance and Design—George Horton and W. B. Franklin, before Petroleum Division, AMERICAN CHEMICAL SOCIETY, Cincinnati Meeting, April, 1940.

This paper presents the derivation of general absorption and stripping factor equations. No assumptions are involved, and hence the equations are applicable to all cases of absorption and stripping. A simple rule is presented to estimate the knockout or stripping gradient from plate-to-plate, and two methods of calculating absorber performance are illustrated.

These methods of calculating absorber and stripper performance have been compared to plate-to-plate calculations. In spite of discrepancies on intermediate plates, good over-all agreement was obtained between both methods and the plate-to-plate calculations.

Propane Precipitation of Petroleum Resins—P. T. Graff and H. O. Forrest, in INDUSTRIAL ENGINEERING CHEMISTRY, Vol. 32 (1940), No. 3, pp. 294-298.

Propane-precipitated petroleum resins contain those hydrocarbons or color bodies which are adsorbed on clays or earths in the treatment and refining of petroleum lubricating oils and which may be dissolved or washed from the clay by solvents such as benzene. These hydrocarbons substances are similar to asphaltenes except that they are not oxidized or combined with sulfur and are therefore soluble in petroleum ether.

Propane fractionating technique provides a comparatively simple process method of producing a "resin" fraction from petroleum and this fraction may represent a portion of the crude petroleum not readily isolated by other industrial process methods available to refiners.

The operation of precipitating resins from a mid-continent crude residuum by liquid propane is a two-stage process; the first stage precipitates the asphalts and the second a resin fraction, leaving a partially refined lube oil base stock dissolved in the propane.

A comparison was made of the effect of propane precipitation and of selective solvent extraction. In one case the residuum was propane-deasphalted and then nitro-benzene-extracted; in the other case propane was used to precipitate a low A. P. I. gravity resin fraction from the raffinate produced by nitrobenzene extraction of the crude residuum. A comparison of the original charge and the intermediate and final products with respect to carbon residue and color (optical density values, *2*) shows that propane precipitation of asphalts and resins is highly effective in concentrating the carbon-forming and color material in the precipitates. The selective solvent improves the paraffinicity, V. G. C., and carbon residue. Per unit volume removed in propane precipitation or in solvent extraction, the greater carbon concentration appears to come in the material settling out of propane solution.

Propane precipitation of petroleum resins is used commercially to reduce the duty of clay in decolorizing lubricating oil stocks.

Propane-precipitated resins from Pennsylvania cylinder stock were oxidized in batch stills; the

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oxidized oils are almost completely soluble in carbon tetrachloride. Users of plastic substances produced from petroleum are advised that it will be possible, by oxidizing the propane precipitated resins, to obtain plastic material with excellent temperature-penetration characteristics, together with great stability.

Solvent Action of Liquid Propane—C. S. Kuhn, Jr., in INDUSTRIAL ENGINEERING CHEMISTRY, Analytical Edition, Vol. 12 (1940) No. 2, pp. 86-89.

A study has been made of the liquid phases formed by the action of liquid propane on the pentane-soluble fraction of a high-temperature bituminous coal tar. As the ratio of propane to tar is increased there is an increase in average density, refractive index, and molecular weight, and a decrease in hydrogen-carbon ratio of the extract, and corresponding changes in the residue. The separation is largely on the basis of molecular weight, but at high tar-propane ratio there is some evidence that alkylated cyclic structures have been preferentially extracted. In general, there is a tendency for oxygen, nitrogen, and sulfur compounds to concentrate in the residue.

Octane Number and Lead Susceptibility—D. L. Yabroff and A. C. Nixon, in OIL AND GAS JOURNAL, Vol. 38 (1940), No. 41, pp. 74-76.

It is well known that the presence of sulfur compounds in gasoline decreases the octane number and the lead susceptibility. The magnitude of this effect is dependent not only on the quantity of sulfur compounds present, but also on the type. Polysulfides are among the worst in this respect, followed by disulfides and mercaptans, thioethers, and thiophenes. Conventional sweetening processes convert mercaptans to disulfides, and in many cases, small amounts of polysulfides are formed as well. As a result of sweetening the octane number and lead susceptibility are lowered to a greater or lesser extent, as compared to the sour gasoline, depending on the particular gasoline, the sweetening process employed, and how carefully the sweetening procedure has been carried out.

The authors call attention to what has been designated as the "solutizer" process by which the mercaptans are removed from the gasoline rather than converted into other sulfur compounds which, though not objectionable in other respects. contribute a great deal to the decrease in octane number and the lowering of lead susceptibility. The solutizer process depends on the use of a caustic solution of high solvency power. The principal virtue of the process is that it reduces the amount of tetraethyl lead required to produce a rise of five octane numbers, and effects a saving of one to five or more cents a barrel in the cost of treating sour or conventionally doctored gasolines.

PIPELINE

Changes and Improvements in Natural Gas Pipe Lines—J. Stanley Stevenson, in REFINER, Vol. XI (1940), No. 6, pp. 113-114.

The author, who is chief engineer of the Panhandle Eastern Pipe Line Co., gives it as his opinion that the recent development of several types of cleaners, or "go-devils," and their successful use in natural gas pipe lines, is one of the outstanding contributions during the last four years to the operation of these lines.

The several types of cleaners developed, although differing in certain respects, are essentially alike in the matter of design of cleaning elements, blades, brushes, etc. All are designed to be propelled through the pipe line by gas pressure with the loosened debris from the pipe wall being carried ahead of the cleaner by the gas stream and blown from the end of the section of pipe line being cleaned. A pressure differential of about 1 lb. per sq. in., or less, is usually sufficient to move the "go-devil" through the line at a desired speed of about 12 m.p.h. An upstream pressure of about 3 to 5 lb. per sq. in. applied to the cleaner is sufficient to maintain this speed. It is sometimes necessary to pass the cleaner through the lines two or more times to attain best results, but it is believed that once encrusted or corroded lines are thoroughly cleaned they will not have to be cleaned again, provided the gas is sweet, is being dehydrated satisfactorily, and gas scrubbers are used on the lines.

It is difficult even to approximate the average improvement in the flow efficiency of lines that might be attained by use of these cleaners, or scrapers. The actual condition of the interior wall of each line tested and the thoroughness of the cleaning job are factors having wide variation and scope. It is not uncommon, however, for efficiencies to be raised 80 to 92 percent, and flow efficiencies as high as 95 percent have been reported to result from the cleaning of a line.

Last year saw an increasing use of a newly developed pipe-line coating machine. Similar to its predecessor, the pipe-cleaning and priming machine, it travels along the pipe line under its own power, balanced and held upright by its operating crew. Hot enamel from a supply tank, heated by two oil burners, flows around the pipe, being applied evenly to the desired thickness by circular spreaders. Excess enamel drains from the pipe, is caught in an open pan under the pipe, and returned by pumps to the supply tanks.

A new feature of the machine was used for the first time in January of this year, on a 24-in. gas line laid in Missouri. Hitherto, pipe-coating machines had been used principally on solid welded lines. On the very few coupled lines painted by the machine the coupled joints were coated by hand, the heavy machine propelling itself over the coupling on a track made of steel plate. On the line mentioned, however, couplings were coated in a specially designed form built into the machine.

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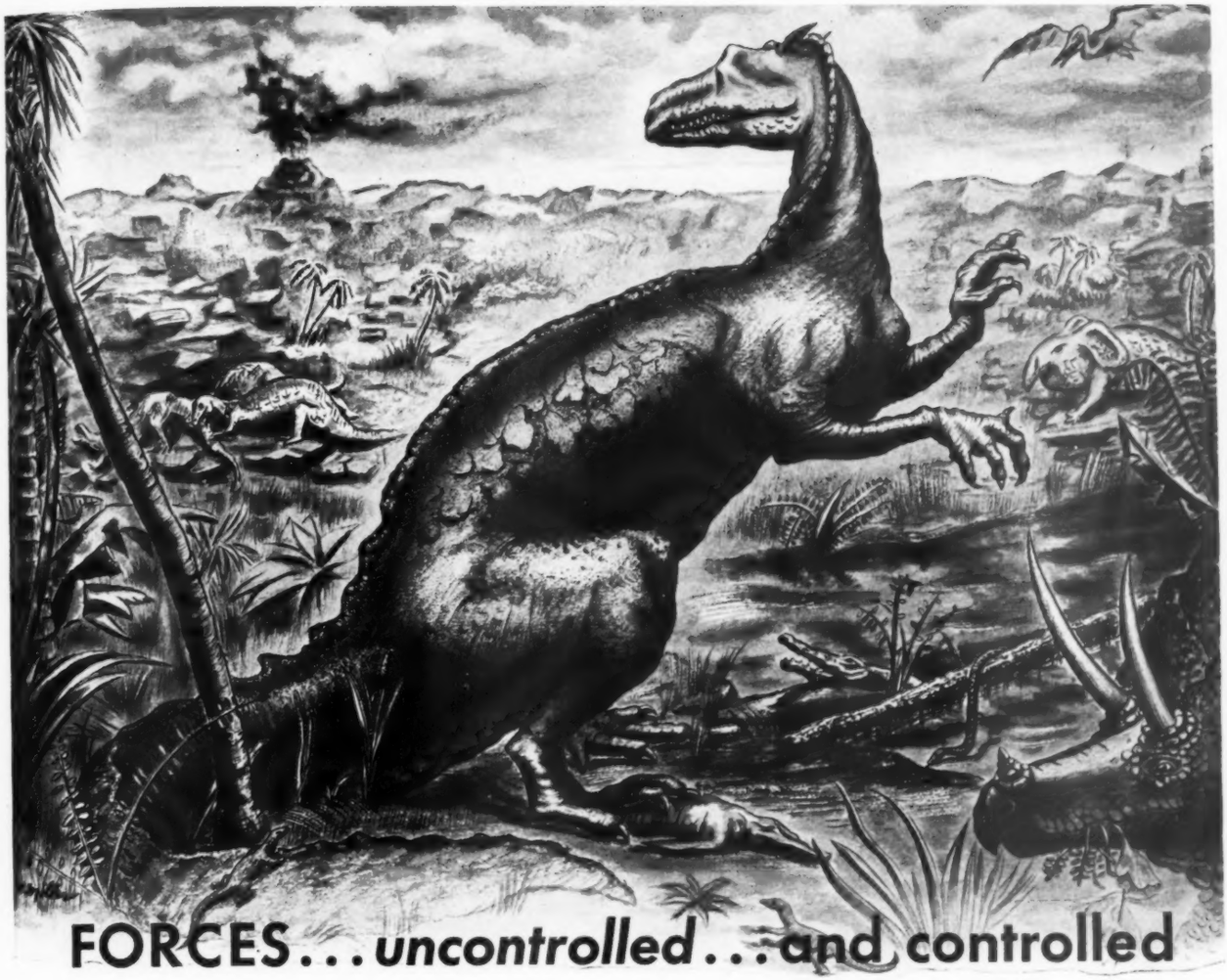
ASPHALT AND TAR

Recent Developments in the Use of Asphalt for Transportation Purposes—Bernard E. Gray, before AMERICAN SOCIETY FOR TESTING MATERIALS, Detroit Meeting, March, 1940.

One important development in asphalt pavements is the increasing attention to subgrade—the actual design of the subgrade as a part of the composite pavement structure having definite minimum support values. The almost universal use of balloon tires has so reduced load concentrations that even though traffic volumes have increased greatly, the damaging effects of impact formerly experienced have now disappeared. It is also pointed out that the development of modern power equipment with attendant low cost of operation has greatly extended the radius of economical haul of selected aggregates and mixtures, as well as manipulation on the roadbed.

Surface types formerly in the higher cost class are now competing in the low cost field, while the



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quality of all types is markedly improved. Also, there is a definite trend toward use of plant mix types, because of lower plant costs and immediate use of road after placement.

There is a definite trend toward use of coarse grades asphaltic concrete both in rural and city work and a growing use of asphaltic concrete for both base and surface courses. Asphalt surfaces for airports are the predominant type, with the trend toward plant mix types using both travelling and central plants. Recent experimental work in construction of asphalt ballast under railroad tracks opens a new field of use.

Physical Constants of Asphaltic Bitumens—R. N. J. Szal, W. Henkelom and P. C. Blokker, in JOURNAL INSTITUTE PETROLEUM, Vol. 26 (1940), No. 195, pp. 29-39.

Those who have to deal with asphaltic bitumens are interested chiefly in such particular properties as consistency, penetration, softening point, brittleness, ductility, viscosity at high temperatures, and temperature susceptibility; these are of principal importance in road building.

For highway purposes there is not quite the same interest in the physical properties of specific gravity, coefficient of cubical expansion, specific heat, thermal conductivity, surface tension, total surface energy and permeability to water vapor, but since the use of asphaltic bitumens for various industrial purposes is also important and is becoming more so, a knowledge of these constants is acquiring greater value.

Contrary to what is true of the industrial characters mentioned in the first paragraph, the physical constants listed in the second are in general only slightly affected by the consistency and origin of the bitumen; that is, these constants are characteristic of fairly large groups of bitumens.

In a general way the specific gravity and penetration at 25 deg. C. are related as follows:

Asphaltic bitumens		Specific gravity at 25°C.
Pen. 100 g./5 sec./25°C.	= 300	1.01
" "	= 200	1.02
" "	= 100	1.02
" "	= 50	1.03
" "	= 25	1.04
" "	= 15	1.04
" "	= 10	1.05
" "	= 5	1.07
" "	= < 5	1.07

These values are for bitumens of the pitch normal, and blown types of the same penetration.

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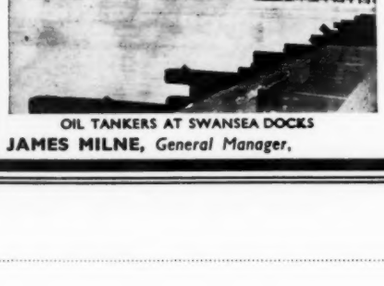

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Bitumens from cracked residues show the following relation between penetration on specific gravity:

Pen. 100 g./5 sec./25 °C.	= 100	1.13
" "	= 50	1.13
" "	= 25	1.13
" "	= 15	1.14
" "	= 5	1.15
" "	= < 5	1.16

Penetration and cubical expansion show the following relationship:

Straight-run bitumens		Coefficient of cubical expansion 15-200° C.
Pen. 100 g./5 sec./25° C.	= 196	0.00060
" "	= 65	0.00061
" "	= 50	0.00061
" "	= 45	0.00061
" "	= 23	0.00062

The specific heats are related to penetration and softening point as follows:

Bitumen	Pen./25° C. IPT.–A. 18.	Soft. pt. R. & B. IPT.–A. 20.	Specific heat in cal./gm./°C. at 0° C.	Change of specific heat per 1° C.
Venezuelan distilled bitumen	177	39½° C	0.425	0.00047
ditto	23	62½	0.409	0.00054
ditto	7	96½	0.382	0.00073
Mexican distilled bitumen	22½	63	0.429	0.00035
ditto blown bitumen	39	84½	0.430	0.00032
ditto	25	86½	0.402	0.00056
Bitumen from cracked residues	2	73	0.419	0.00040
Light-colored bitumen	25	53	0.378	0.00078

The heat conductivities of the above bitumens at 0 deg. C. are of the order of 0.136 to 0.150 kg.-cal/m/° C./h, and 0.121-1.136 at 70 deg. C. Permeability to water vapor of bitumen sealing compound is about the same as for plasticized cellulose acetate.

CHEMISTRY

Separation of the Aromatic Hydrocarbons and the Isolation of *n*-Dodecane, Naphthalene, *i*-Methylnaphthalene, and 2-Methylnaphthalene, from the Kerosene Fraction of Petroleum. Beveridge J. Mair and Anton J. Streiff, before Petroleum Division, AMERICAN CHEMICAL SOCIETY, Cincinnati Meeting, April, 1940.

This paper is the first report on the separation of the hydrocarbons in the kerosene fraction of petroleum, which investigation is being carried on as part of the work of the American Petroleum Institute Research Project 6. That part of the petroleum distilling between 114 deg. and 144 deg. C. at a pressure of 56 mm. Hg (corresponding approximately to 200 deg. and 230 deg. C. at 760 mm. Hg) was separated into a series of substantially constant boiling fractions. From the material distilling between 127 deg. and 133 deg. C. (at 56 mm. Hg), *n*-dodecane was isolated by crystallization. All of the material except the isolated *n*-dodecane was then subjected to a systematic extraction with reflux in a two-solvent process in order to separate the aromatic hydrocarbons from the paraffins and naphthenes. The "clean-up" of the traces of aromatic hydrocarbons was accomplished by adsorption with silica gel. The aromatic fractions were then systematically distilled in fractionating columns of high efficiency. From the material boiling at 56 mm. Hg. between 127.0 and 127.5 deg. C., 145 and 146.5 deg. C., and 148. deg. to 149.0 deg. C., respectively, naphthalene, 2-methylnaphthalene, and 1-methylnaphthalene were isolated by fractional crystallization.

"Best" lots of each of the four hydrocarbons were prepared, with impurities estimated to be, in terms of mole fraction: *n*-dodecane, 0.0000+0.0006; napthalene, 0.0006+0.0004; 1-methylnaphthalene, 0.0025+0.0011; 2-methylnaphthalene, 0.0000+0.0003. Values of certain physical properties of these four hydrocarbons, all extrapolated to material of 100 percent were determined as shown in the above table.

Hydrocarbon		*n*-Dodecane	Naphthalene	1-Methylnaphthalene	2-Methylnaphthalene
Boiling point at 760 mm.,	°C.	216.26	217.96	244.78	241.14
Freezing point in air,	°C.	−9.60	80.27	−30.77	34.44
Density at t° C.,	g/ml.	0.74512	0.9752	1.0163	0.99045
Refractive index at t° C.,	nD	1.41951	1.5898	1.61494	1.60192
Refractive dispersion at t° C.,	nF-nC	0.00733	0.0289	0.02995	0.02899
Temperature of density, refractive index, and dispersion measurements,	°C.	25	85	25	40

PHYSICS

Investigating Power Fuels by Raman Spectral Analysis—J. Goubeau, in OEL UND KOHLE, Vol. 15 (1939), No. 32, p. 633.

The chief use of Raman spectral analyses is in organic chemistry, which includes petroleum hydrocarbons. Every substance has its characteristic Raman spectrum. This is due to the arrangement of the atoms in the molecule, the number of atoms, and the nature of the bond between the atoms. For these reasons the slightest difference in the structure of the molecule produces a difference in the spectrum, so that it is possible to distinguish between all kinds of isomers, whether chain isomers or position isomers, including cis-trans isomers. A Raman analysis is therefore of importance when applied to power fuels. The most different kinds of hydrocarbons, whether with straight or branched molecules, olefins, cyclic and aromatic compounds with and without side chains, can with certainty be detected in mixtures. The test sample must have a purity of at least 99 percent. Tyndal effects and fluoresence create difficulty, because under unfavorable conditions these two effects may be stronger than the Raman effect, and special measures must be taken to get rid of them.

The appearance of lines that are characteristic of definite atomic groupings within the molecule is a great convenience, because it allows the presence of certain classes of compounds to be detected at a glance. In the case of hydrocarbon fuels it is sufficient to obtain an idea of which of the principal classes of compounds are present.

Some Free Energy Data for Typical Hydrocarbons Containing Six or More Carbon Atoms—George S. Parks, before Petroleum Division, AMERICAN CHEMICAL SOCIETY, Cincinnati Meeting, April 1940.

The third law of thermodynamics has been used to determine the free energies of formation of a number of typical hydrocarbons containing six or more carbon atoms. The sequence — paraffins, cycloparaffins, olefins, monocyclic aromatic, polycyclic aromatics—represents the general order of increasing free energy values at room temperature. The quantitative effects associated with hydrocarbon type, CH^2 increments, branching, etc., are evaluated with considerably greater accuracy than in the past, due mainly to the utilization of modern, highly reliable data for the heats of combustion involved.

Static Friction of Lubricated Surfaces—A. Fogg and S. A. Hunwicks, in JOURNAL INSTITUTE PETROLEUM, Vol. 26 (1940), No. 195, pp. 1-18.

The object of this research was to obtain light on what is referred to as "boundary friction" or the "oiliness" of various substances. What is meant is indicated as follows:

The two chief properties of fluids which determine their lubricating value are viscosity, and some other property, independent of viscosity, usually known as "oiliness." Under static conditions any effect due to viscosity must necessarily be absent, since, by definition, viscosity is that property of a fluid which determines the resistance of the relative sliding motion of adjacent layers. The only resistance to the commencement of motion, therefore, is that due to the attractive forces between the solid surfaces as modified by the layer of lubricant between them. The effectiveness of this layer, known as the boundary layer, in reducing the attractive forces becomes a measure of the boundary lubricating properties of the lubricant which must be closely associated with "oiliness."

By means, therefore, of measurements of the resistance to the commencement of motion, *i.e.*, the static friction, a direct measurement of a property associated with oilness can be made. It is pointed out that oiliness is not a product of the liquid in bulk, but only of the boundary layer.

The apparatus used in the investigation was a modified Daly machine in which three small balls are enclosed between two steel surfaces, the lower one of which can rotate while the upper one carries different weights or loads. The arrangement has given results which are sufficiently consistent to distinguish easily between the "oiliness" of different classes of oils, *e.g.*, mineral and fatty, and of oils in each class. It is suggested, therefore, that the machine should be used to supplement existing tests for lubricating oils, since this property which it measures is of vital importance in practice.

Calculating Gasoline Octane Rating from Gravity and ASTM Distillation—R. B. Cox in REFINER, Vol. 19 (1940), No. 2, pp. 43-48.

Determination of the octane number of a gasoline by a standard engine is an expensive and time-consuming operation. Many attempts therefore, have been made to correlate this octane number with various of the physical properties of the gasoline. A good correlation would eliminate the use of the standard engine; a mediocre correlation would at least give the operator of the standard engine some idea of the octane rating to be expected so that he could more quickly determine which reference fuels to use, thus reducing the cost and time required for the test.

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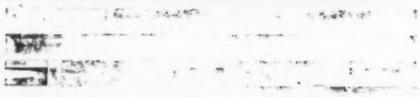

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Where a series of tests are to be run on gasolines having varying octane ratings, as in crude oil analysis, which require the use of different reference fuels, it is a distinct advantage to know in advance the approximate octane rating of each sample so that when the engine is once set for particular reference fuels, all samples requiring those fuels may be run at once. When run in this manner the time required for the tests may be reduced by about 30 percent.

It is the purpose of this paper to present methods of calculating the octane rating of any gasoline by using only its A.P.I. gravity and A.S.T.M. distillation. All gasoline samples are subjected to at least these two tests, even in control work, so that the calculation proposed here require no tests other than those that are made in any case. This obviates the objection that has been made to other methods of octane number predetermination. Moreover, these two basic tests are simple, reproducible, accurate, require no complicated apparatus, and may be determined by one operator in a total elapsed time of 35 minutes.

As the basis of the method the author has obtained the actual octane ratings of a great variety of gasolines whose A.P.I. gravity and A.S.T.M. distilations are known. From this data he constructs graphs and formulas by which the octane number may be read off with ease.

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Some Observations on the Thermodynamics of Hydrocarbons and Related Compounds.—John G. Aston, before Petroleum Division, AMERICAN CHEMICAL SOCIETY, Cincinnati Meeting, April, 1940.

It is shown that it is necessary to take account of potentials hindering free rotation in calculating thermodynamic functions of hydrocarbons and related compounds from the spectrascopic and molecular data. Values obtained from the third law are correct.

By using the third law results, down to 10° K., the necessary potentials can be obtained and thermodynamic functions calculated from 300° K. to 1200° K., with the aid of the spectroscopic and molecular data.

Thus $dF°/T$ values are obtained for normal butane, normal pentane, and neopentane from 300° K. to 1200° K. based on thermal data down to 10° K. obtained in this laboratory. The results on the first two make it possible to get free energy values for the higher normal paraffins.

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